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Photograph by Paul Williams

FRANCIS B. SUMNER

Francis B. Sumner [1]

1874 - 1945

A LEADING American zoologist, many of whose researches dealt with and shed clear light on the biology of fishes, passed away quietly on September 6, at La Jolla, California. There is little need to report the life story of FRANCIS BERTODY SUMNER, Professor Emeritus of Biology at the Scripps Institution of Oceanography of the University of California. He himself told the tale in a fascinating autobiography, "The Life History of an American Naturalist," which very happily came off the Jacques Cattell Press just in time to be appreciated by the author.

It is imperative to note, however, that, in some respects, this book presents a picture of "F.B." which his close friends would have resented, had it been written by another person. A remarkable combination of modesty, reticence and individuality, coupled with an allocation of truth far above all sentiment and tradition, led him to an underevaluation of his own high achievements and to an imperfect representation of his own fine personality. Election to such honors as the Vice-Presidency of the A.A.A.S. and to membership in the American Philosophical Society and the National Academy of Sciences gave some measure of his eminence, as this was appreciated by his colleagues. His transcendent intellectual courage and sincerity, his discerning wisdom and keen wit, forced respect among all acquaintances and endeared him to his intimate friends. Far from being an academic recluse Sumner was charged with social consciousness. He took an active part in nature-preservation and birth-control movements, which to him were phases of a single problem. He vigorously combatted the "boosters" and the anti-vivisectionists. He was a fearless champion of the minority.

Throughout his long scientific career Sumner courageously attacked problems that others had avoided, either because the tasks were of too forbidding magnitude or because the researches were not in line with the current trend or fad of biological thought. His liberal, free-thinking mind led him to favor or at least to investigate open-mindedly such unpopular ideas as the inheritance of acquired characters and the non-particulate inheritance of "normal" characters—until the weight of evidence from his own impartial research finally forced him to accept the conventional viewpoint. His perplexed leaning toward "extrasensory perception" was never wholly abandoned, though his own limited studies in this field gave negative results. Keynotes of all his diverse researches were rigorous intellectual honesty, intense self-criticism, extreme thoroughness and precision. Each problem was rounded out and concluded before another, likely very different, was undertaken.

Sumner's name will probably remain most closely and most favorably associated with his longest research, the brilliant analysis of speciation in mice of the genus *Peromyscus*, but most of his separate studies were conducted on fishes. He was not primarily an ichthyologist, for his problems were those of general biology, but he used fishes as subjects and he did his

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1 Contributions from the Scripps Institution of Oceanography of the University of California, New Series No. 263.

work so competently, that he ranks as one of the outstanding contributors to general ichthyology. His first paper, with Bashford Dean, dealt with the spawning of a brook lamprey. His doctoral thesis at Columbia, on "Kupffer's Vesicle and Its Relation to Gastrulation and Concrescence," involved some pioneer experimentation. His early study of the physiological adaptation of fishes to changes in salinity was significant, though the methods of a rising clique of physiologists were avoided. A brilliant research on color adaptation in flounders opened a new field. Biological surveys of the Woods Hole region and of San Francisco Bay, which then intervened, proved Sumner to be a competent field naturalist as well as an able experimentalist.

On the discontinuance of the *Peromyscus* project Sumner returned to fish biology, to make very significant contributions on the mechanism of color change. Temperature and respiratory adaptations were then thoroughly studied in the laboratory and in hot springs. He carried out the most conclusive tests ever made of the survival value of individual color adaptations. Quantitative studies of the long-period changes in the amounts of melanin, carotenoids and guanine in the skins of fishes, under different optic stimuli, are acclaimed for their originality, precision and significance. The recent successful conclusion of these experiments proved that Sumner maintained to the end of his research career an ability to overcome such great obstacles as inherent technical difficulties and a limited training in biochemistry.

These final researches were completed and published. The last in a stimulating series of essays, this one entitled "A Biologist Reflects upon Old Age and Death," had appeared. "The Life History of an American Naturalist" had just come out. Social and political movements dear to his heart had come to fruition or to some promise of achievement. Peace had returned to the world. Keenness of mind had persisted and happy relations with family and friends retained. Could death have been better timed?—CARL L. HUBBS, *Scripps Institution of Oceanography, University of California, La Jolla, California.*

On the Methods of Measuring Fish [1]

By WILLIAM E. RICKER and DANIEL MERRIMAN

THE old dispute as to how best to measure fish has been aired recently in papers by Royce (1942) and by Carlander and Smith (1945). Fish lengths can be classified into two principal types, the *standard* and the *total.* Of the former, used primarily by systematists but also by fishery biologists at times, no less than five varieties are described in the two publications just cited, and three more have come to light in the course of inquiries made in preparing the present paper:

1. To the line between the last unmodified vertebra and the anterior swelling of the hypural plate. Very often, with this and other measurements which are made to a point which can be revealed only by dissection, the dissection is done on a few specimens, and the position of the point in question is thereafter estimated from external form.

2. To the branching of the hypural plate—that is, the point directly

1 Contribution from the Department of Zoology, Indiana University (number 348), and from the Bingham Oceanographic Laboratory, Yale University.

above which the urostyle starts to bend dorsally, and from which the major hypural elements fork.

3. To the anterior end of the median caudal fin rays. In many species a vertical groove can be found externally at this point by using a blunt knife or similar instrument; flexing the tail a little also sometimes shows a distinct crease. (This crease is often identified as the posterior end of the hypural plate, but the fin rays usually overlap the plate slightly.)

4. To the posterior end of the hypural plate, at or near the median axis of the posterior part of the vertebral column. (In some species the plate is not continuous across the *exact* median axis.)

5. To the end of the fleshy part of the caudal peduncle.

6. To the last scale in the lateral line.

7. To the posterior limit of scutellation on the caudal peduncle.

8. To the end of the silvery area on the caudal peduncle after the scales have been scraped away.

While our survey of current usage has not been exhaustive, it is clear that no one of the above procedures occupies any predominant position, though numbers 2, 6, and 7 appear to be rather rare. Numbers 3 and 4, together, are perhaps most favored; however, Royce believes number 1 to be most often employed. Possibly still other definitions are in use.

The total lengths, used by fishery biologists in particular, terminate at the end of the caudal fin, instead of in the general region of the caudal peduncle. When a fish has a rounded tail, with the median rays longest, it is obvious that total length should be measured to the end of such rays. However, tails of this kind occur in only a minority of species. The majority have the tail emarginate or forked, in which event three alternative methods of taking total length are available:

1. The *median length,* which lies on a continuation of the line formed by the posterior half of the main vertebral axis. This has also been called the *mid-caudal length,* or the *fork length,* since in most species it comes to the middle of the fork of the fin.

2. The *natural tip length,* measured to the end of either lobe of the tail, whichever is longer, when lying in a natural position.

3. The *extreme tip length,* measured to the end of either lobe of the tail, whichever is longer, when squeezed to the position of maximum extension.

Of the above, numbers 1 and 3 are in common use on this continent, while number 2 is apparently less common. Other definitions of total length are in use elsewhere. For example, in England herring are sometimes measured "to the distal end of the longest ray in the dorsal fluke of the caudal fin, when the fluke is placed so that its dorsal margin lies parallel to the line of measurement."

The present writers are both already on record as favoring one of the total lengths, namely median (fork) length, for most purposes (Merriman, 1941; Ricker, 1942). Royce (1942) and Carlander and Smith (1945) also prefer one of the total lengths, extreme tip length, on the basis of experiments which, taken at their evaluation, favor median length almost or quite as much. However we do not find the arguments of these authors to be particularly cogent. Carlander and Smith show the results obtained by different observers who measured three species of fish by five different methods,

in terms of the standard deviation of each. Certain differences appear between the various methods, some of which are probably significant, although the authors appear to overlook the fact that in selecting from among a large number of possible comparisons, much more stringent criteria of significance are necessary than when a unique comparison is being tested.

However the important question is not the relative variability of the different methods of measuring, but rather the variability of each of them when compared with the natural variability of fish populations. A very little research is sufficient to show that, when such a comparison is made, none of the standard deviations discovered by Carlander and Smith are of any importance whatever. For example, in a study of the weight-length relationship, the variation in weight at a given length is such that error due to inconsistency of measurement can be neglected by comparison—at least in any investigation that has come to the writers' attention. Or suppose it is a question of ascertaining the mean size and frequency distribution of the fish caught in a gill net of a given mesh, or of the fish of a given age in a population. In such a situation lengths are usually grouped into frequency classes at least 5 millimeters broad, and the extra variability introduced by this grouping, insignificant though it is in relation to the natural variability of the fish in question, is greater than the apparent difference in variability between one or another system of measuring. To illustrate, it was found that white crappies of age-group II in a certain population had a standard deviation in length of about 40 millimeters, or 8 half-centimeters; hence they had a variance of 64 in the latter system of units. The largest standard deviation found by Carlander and Smith in measuring crappies, by any method, was 1.43 millimeters, or 0.286 half-centimeters, which means a variance of 0.082. The variance introduced by grouping the fish at half-centimeter intervals is $\frac{1}{12}$, or 0.083 (Sheppard's adjustment). Thus the variability introduced in the process of measuring is of the same order of size as that introduced by grouping at 5 millimeter intervals, and both are equal to only about $\frac{1}{770}$ of the natural variability of the population. The *differences* in variability between any two systems of measurement are of course considerably less again.

Royce's argument for total length is that weight is better correlated with extreme tip length than with standard length, in four species which he investigated. From this he concludes that considerable economies of effort can be achieved; for example, "it would require 216 specimens to estimate the mean weight of rock bass from standard length to within 2 per cent, whereas with the use of total lengths the same degree of accuracy could be obtained with only 114 specimens." This argument overlooks the fact that such an estimate of weight from lengths could be made only if the regression of log weight on log length were established beforehand. However, the equation of this regression line is notoriously variable—it can vary with sex, with season, and even with time of day (depending on the amount of food in the stomach); and it often exhibits very marked differences in different bodies of water. Also, it has by no means been shown that the regression of logarithm of weight on logarithm of length is under all circumstances exactly linear, so that small systematic deviations from the regression line, such as could not be demonstrated except with very large samples of fish, are an additional

possible source of error. Thus in practice it is impossible to avoid actually weighing the fish in every sample taken, if a mean weight having an accuracy anywhere near 2 per cent is to be achieved. And there still remains the question of to what extent the sample represents the population, for which the same considerations apply for weight as for length. It must be mentioned, too, that Carlander and Smith failed to confirm Royce's discovery, and found practically no differences in the correlations between weight and four lengths (two standard and two total), though they used two of the same species of fish as Royce.

It appears, therefore, that the studies of Royce and of Carlander and Smith lead to a conclusion somewhat different from the one which they themselves come to. What these authors have really shown is that almost *any* length measurement, if it can be clearly defined, is amply accurate for all ordinary purposes. Those who now use a standard length cannot expect to improve the accuracy of their data noticeably by changing to a total length. If such a change is being considered, it should be judged on other grounds.

Since all types of measurements are, for practical purposes, equally accurate, the criteria to be considered in choosing a measurement appear to be limited to those of *convenience* and *uniformity*. What constitutes convenience varies with the species under consideration [2] and with the apparatus available. Thus some investigators, particularly those handling clupeid fishes, use a measuring board with a sliding cross-hair and pointer, so that the fish is not in contact with the scale. This makes one kind of measurement as easy to read as another, and since the tails of these fishes often become damaged by handling in the commercial fishery, some form of standard length is more convenient.

Investigators who use less elaborate apparatus can rightly claim that a total length has decided advantages, because it is taken at the edge of the fin and flat against the measuring scale, so that the point on the scale is not covered by the caudal peduncle. Among total lengths, we believe median length easily leads the field. Live fish usually spread their tails, and recently-dead fish usually have them spread, so that the median length can be read without touching the tail at all. This is a great help under any conditions, but it is particularly convenient when the second hand is required for other duties. On a boat at sea, for example, the observer may require one hand to steady himself. In quiet waters or on shore, an observer working alone can take the median length of small fishes using only one hand on the fish, thus keeping the other dry for handling pencil and paper. Occasionally the tail needs a little adjustment, which can readily be done with the tip of the pencil or any other convenient object. For extreme tip length, on the other hand, it is invariably necessary to hold the fish with one hand and squeeze the tail with the other, which means that the pencil and recording sheet soon become messy, and also that considerable time is wasted. For large active fishes where two hands are needed to hold the fish on the measuring board, it is almost impossible to take a satisfactory extreme tip length without a

2 In a minority of species the lower jaw projects beyond the snout, so that there is a choice of measurements even at the anterior end of the fish. Systematists using standard length usuallly measure to the tip of the snout or upper lip (Hubbs and Lagler, 1941), while in biological investigations the tip of the lower jaw with the mouth closed seems to be commonly employed, whenever it projects beyond the snout. This latter procedure is to be recommended for the "biological" worker, because of its much greater convenience when a measuring board is used.

second observer to cooperate in the actual measuring. "Natural" tip length usually has all the disadvantages of extreme tip length, plus the difficulty of deciding what position of the tail is really natural. For those who are unfamiliar with median length and may still doubt its advantages, we can suggest two situations especially appropriate for trying it out: on a tossing trawler, when attempting to complete work on one haul before the next one comes in, and with the handicap of a queasy stomach; or by a trout stream while a "rise" is on, with several hundred fish that *must* be measured, and the observer desperately anxious to try his own fly rod for an hour or so before dark!

Turning to the argument from uniformity, it is obvious that there is no uniformity at the present time, so that the question is principally one of possible future benefits, rather than of what is immediately at hand. And general uniformity seems highly improbable in the future. Systematists are certainly not likely to abandon standard length, nor are the investigators of clupeids mentioned earlier. On the other hand, the trend among many "fishery" workers has been away from standard length in recent years, and a proposal to return to it would meet widespread opposition, even if a decision could be reached on what type of standard length really is "standard." However, if the criterion of convenience could be agreed upon by fishery biologists and median length were adopted generally, except where important peculiarities of the fish in question made another length desirable, then a greater degree of uniformity than now exists would follow automatically.

The question of what length is now most commonly used seems a minor one, yet since others may weigh it differently we can briefly summarize present American usage—at least as regards the total lengths. Carlander and Smith claim that extreme tip length is most common, but it is significant that these authors are most familiar with conditions in the middle western states. This indeed seems to be the native home of extreme tip length; it is used in most or all states of the region (except Indiana!), and it has spread south and to some extent east. Over the continent as a whole, it is much less widely used. Disregarding those who use nothing but standard length, we find that median length is used by almost all investigators of the U. S. Fish and Wildlife Service in coastal states, for the great majority of the marine and freshwater fishes which they handle. It is used by most or all state and university investigators in all the Pacific coast states, more than half of the eastern ones, and locally elsewhere. It has long been universal in Canada for both marine and freshwater investigations, whether carried out by the Dominion's Fisheries Research Board, or under provincial or university auspices. It is evident, then, that median length is the most widely used total length measurement on this continent, either in terms of number of investigators, or number of species, or, above all, in terms of the quantity of individual measurements. Concerning other parts of the world we have little information, but median length appears to be standard practice in the British Isles, for salmon and trout investigations at least. It also seems likely that median length is more widely used than any single type of standard length, though possibly not more so than standard lengths collectively.

An investigator in the middle-western part of the United States, who be-

lieved that prevailing practice should govern his choice of a length, would have the difficult task of choosing between a fairly well established local usage favoring extreme tip length, and the possibility of a wider uniformity offered by median length. Investigators elsewhere can scarcely hesitate to adopt median length if they rate uniformity as a cardinal virtue. To the writers, the fact that median length occupies a predominant position is much less important than its greater physical convenience, and we certainly would not urge its adoption in a situation where for any reason that advantage did not exist, if it meant breaking a long-standing tradition.

Some investigators make a practice of taking both a standard and one or more total lengths. This is feasible in studies involving relatively small numbers of specimens; where large numbers of fish are being handled it becomes both tiresome and wasteful. Even where two or more lengths are consistently taken, analysis is commonly based on only one of them, and the others are used solely to determine conversion factors. Consequently it seems unreasonable to do more than take enough duplicate measurements to obtain such factors.

Another argument, that extreme tip length is the usual legal length and is also the public's idea of a fish's length, seems to have little to recommend it. In our experience, most fishermen have no definite idea of how a fish should be measured. Left to themselves, they usually try to measure to the tip of the tail in a normal position, which in many species gives a length about half way between median and extreme tip. Almost always they will ask how a fish should be measured, instead of trying to demonstrate it; and they will commonly accept any system shown them. This is, of course, as it should be, for in such a matter it is surely not too much to ask of scientists that they provide leadership, instead of acquiescing passively in an inconvenient procedure. We realize that the fisherman may develop much more positive views when accosted by a warden brandishing a ruler, but since fish measured under such circumstances are apt to have dislocated vertebrae and muscles torn by hypertension, they are of little interest to biologists! More seriously, biological investigations only infrequently impinge on the field of legal length limits, and when they do, the change from one unit to the other can be made in a matter of seconds.

Both of the present writers were "brought up" on median length, so they are quick to admit that some of the above arguments may be tinged with rationalization. *Wir Menschen unterliegen unsere Gewohnheiten* is a saying that has wide application. However, those who favor other lengths are doubtless similarly affected, in most if not all instances.

There is a difference, of course, between making a decision as to what length to use in a new investigation, and deciding to make a change from a length already in use. In the latter situation a change from standard or extreme tip to median length would often involve many inconveniences in analysis which might well outweigh the advantage of greater ease in making the actual measurements; or rather, it might take some years for the latter advantage to outweigh the initial disadvantage. For this reason we do not anticipate any rush to change established practices, even in the (possibly unlikely) event that some will be convinced that such a change would be beneficial in the long run. But anyone anywhere who is initiating a new or

expanded research program would do well to give median length thorough consideration and thorough trial.

There is one point on which all will agree: that whatever length is used, it should be explicitly stated, or even described, in every publication issued. At present, considerable historical research is often needed to find how fish have been measured. In this connection it seems important that in the future, "total length" should be used only as a collective term, and not as a specific one. It is currently used to mean either median length or extreme tip length, in places where each of these is customary. Ignorance of this fact has led to considerable confusion in the past, and will doubtless continue to do so in the future until unambiguous terms are substituted. Exactly the same considerations apply to the term "standard length."

There will always be a need to convert from one system of lengths to another, and for this purpose sets of conversion tables will be extremely useful. During the last two years the Bingham Oceanographic Laboratory has measured several hundred thousand fish from the southern New England trawl fishery. While median length has been the regular practice, standard length number 4 and extreme tip length have also been accumulated for approximately twenty of the most common species, and this material is available for anyone needing conversion factors. For freshwater fishes, Carlander and Smith have published an excellent compilation involving 22 species. The factors computed from their own measurements are for converting standard length number 5, or less often number 3, to extreme tip length and usually also to median length. Unfortunately, it is not always clear which type of standard length is involved in the factors which they quote from literature. Of course the standard lengths, particularly numbers 3, 4, and 5, usually differ among themselves less than do the total lengths, so for many purposes failure to distinguish among the former is not too serious. For the record, it can be mentioned that standard length number 3 was used in Ricker's (1942: 165) conversion factors for bluegill sunfish.

Summarizing, we believe it has been shown, for fishery biologists, 1) that methods of measuring fishes are often inadequately described in contemporary publications, and that the terms "standard" and "total" length have no generally-recognized exact meaning; 2) that all the length measurements currently in use, if they are clearly defined, can be duplicated sufficiently well so that variability from this source is insignificant in comparison with the natural variability of fish populations; 3) that no universal system for measuring fishes is practical or (balancing its advantages and its disadvantages) desirable, though much of the present diversity of practice appears to serve no useful purpose; 4) that convenience is almost the only criterion to be considered in selecting a length, it being a much stronger argument than uniformity would be, even if the latter existed (which it does not); 5) that for biological investigations median length is considerably more convenient than other lengths for the great majority of fishes, except where special measuring apparatus is used, in which event a standard length may at times be superior; 6) that when the lower jaw projects beyond the snout, its tip should be taken as the anterior end of the fish, this again being the more convenient procedure; 7) that the general adoption of the criterion of

convenience would make for a considerably greater degree of uniformity in the future; and 8) that median length is now and has always been much more widely used than its principal competitor among total lengths, considering the country or the continent as a whole.

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Department of Zoology, Indiana University, Bloomington, Indiana, and Bingham Oceanographic Laboratory, Yale University, New Haven, Connecticut.

Determination of Mortality Rates from Length Frequencies of the Pilchard or Sardine, *Sardinops caerulea* [1]

By Ralph P. Silliman

The Objective

THE Pilchard Investigation of the United States Fish and Wildlife Service has set as one of its goals the determination of the characteristics of the average annual catch at various fishing intensities. One step in the attainment of this objective is the determination of mortality rates at the various fishing intensities. For current fishing rates data are available from the application of two methods: tagging and the assessment of age of individual fish by means of scales. During the period of lower fishing intensities prior to 1933, however, these techniques had not been developed. As a member of the staff of the pilchard investigation, therefore, I spent much time and effort in an attempt to deduce mortality rates from length frequencies, which were available for the years prior to 1933. The method described below represents the most satisfactory of the various techniques which I have tried to date.[2]

1 Published by permission of The Director, U.S. Fish and Wildlife Service.

2 The formulations were inspired by, and are parallel to, similar ones for the *weight* of the plaice stocks of the North Sea, as set forth by Baranov (1918).

The Method

If we consider that all of the fish at and above a certain minimum length in a population are fully available to the fishery, then the length frequency of sizes of fish above that length in the catch represents that segment of the population. If we further assume that recruitment is unform, and that mortality is the same for all sizes above the minimum, the following relationship will hold true:

$$N=N_0e^{-kt} \tag{1}$$

where N_0 represents the number of fish annually attaining the given size, N the number at any age t (in years), and k is a constant to be determined from the data.

In the pilchard population, growth of the fish over a certain range of sizes may be expressed (this is explained on page 194) by the formula:

$$L=a+b(A\text{-}22)^3 \tag{2}$$

where L is length in millimeters at any age A, and a and b are empirical constants. Letting $l=L-a$ and $t=A-22$ we have:

$$l=bt^3 \tag{3}$$

Combining expressions (1) and (2) gives:

$$lN=bt^3\ N_0e^{-kt} \tag{4}$$

To obtain the average length of fish above the minimum, we need the total (S_L) of their lengths. This total may be expressed as the definite integral, from $t=$"the age at the minimum length" to $t=$ infinity, of the function represented in formula (4):

$$S_L=\int_T^\infty bt^3\ N_0e^{-kt}\ dt$$

$$\text{or: } S_L=bN_0\int_T^\infty t^3\ e^{-kt}\ dt \tag{5}$$

where T is the age of the fish when they reach the minimum length. Integration of (5) gives:

$$S_L=\frac{bN_0\ e^{-kt}\ T^3}{k}\left\{1+\frac{3}{kT}+\frac{6}{(kT)^2}+\frac{6}{(kT)^3}\right\}$$

To obtain the total *number* of fish (S_N) above the minimum length expression (1) is integrated:

$$S_N=\int_T^\infty N_0\ e^{-kt}\ dt$$

$$S_N=\frac{N_0\ e^{-kt}}{k} \tag{6}$$

The average length ($\bar{l}$) of fish above the minimum is the quotient of total length S_L by total number S_N:

$$\bar{l}=\frac{S_L}{S_N}=\frac{bN_0e^{-kt}T^3}{k}\left\{1+\frac{3}{kT}+\frac{6}{(kT)^2}+\frac{6}{(kT)^3}\right\}\div\frac{N_0e^{-kt}}{k}$$

$$l=bT^3\left\{1+\frac{3}{kT}+\frac{6}{(kT)^2}+\frac{6}{(kT)^3}\right\} \tag{7}$$

Letting r represent $\left(l + \frac{3}{kT} + \frac{6}{(kT)^2} + \frac{6}{(kt)^3}\right\}$:

$$\bar{l} = bT^3 \quad r$$

$$\text{or:. } r = \frac{\bar{l}}{bT^3}$$

(8)

The values of $\bar{l}$, b and T^3 proceed from the observational data, and the equation can be solved for r. By means of a graph (Fig. 1) showing r as a function of kT, the value of kT corresponding to a given value of r may be found. With values of T and kT at hand, k is found simply from:

$$k = \frac{kT}{T}$$

(9)

k in the instantaneous total mortality rate, and may be converted to the annual percentage mortality rate by use of a table such as that published by Ricker (1944: 25).

The Application to the Pilchard

It has been indicated above that the growth of the pilchard for the size range considered conforms to the expression:

$$L = a + b(A\text{-}22)^3$$

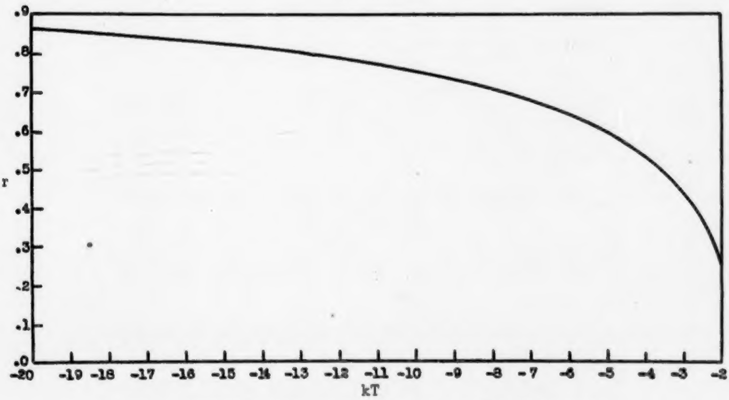

Fig. 1. Relation between kT and r, as explained in text.

The growth data used in this study were taken from Clark (1936). She gives a series (her table 4) consisting of the medians of plus deviations of dominant size groups from an average frequency curve. The lengths are as follows: for the 1st season in the fishery 200 mm.; 2nd, 212; 3rd, 219; 4th, 224; 5th, 230; 6th, 244; 7th, 245; 8th, 249; 10th, 257. These data, fitted according to the above formula, are shown in Figure 2, letting the first season in the fishery correspond to age 2. The values of the constants are: a=268 and b=.008436. Clark has placed question marks after the last four values of the series, indicating less reliability of the data. The points do lie

along the curve, however, and the final results differ little from those obtained from as yet unpublished scale age determination data.

Empirical length frequencies for the California fishing ports of Monterey and San Pedro are given in Clark (1931), in the form of graphs and Figure 4 of that publication gives an 11 season average of the combined Monterey and San Pedro length measurements covering the seasons 1919–20 through 1929–30. This is a long enough period to average out the recognized (Clark, 1931) fluctuations in recruitment, and may be used to illustrate the application of the method to pilchard material.

By planimiter measurement the mean length of fish above an arbitrarily chosen minimum of 217 mm. was determined to be 240.7 mm. Since $\bar{l}$ was defined as equal to $L-268$, and $L=240.7$, $\bar{l}=240.7-268=-27.3$. The arbitrary minimum length of 217 is substituted in expression (2), along with the value of a of 268 and b of .008436, giving:

$$217 = 268 + .008436\ (A-22)^3$$

From this $A-22=-18.2$,, and since t has been defined as equal to $A-22$, -18.2 is T, the particular value of t at the minimum length of 217 mm.

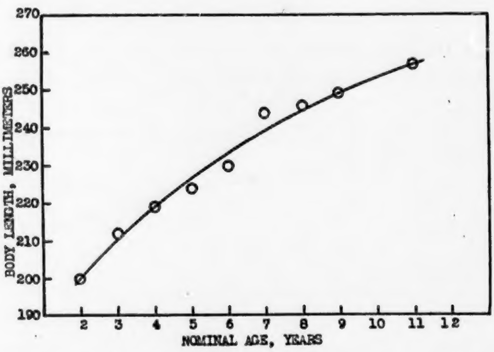

Fig. 2. Growth curve for the pilchard, consisting of the function Length = 268 + .008436 (Age—22)³ fitted to the empirical body lengths (circles) given in Clark, 1936, table 4.

We now have the values necessary for substitution in formula (8):

$$r = \frac{\bar{l}}{bT^3} = \frac{-27.3}{.008436(-18.2)^3} = .537$$

From Figure 1 this value of r corresponds to a value of kT of -4.1 Using this and the known value of T in formula (9)

$$K = \frac{kT}{T} = \frac{-4.1}{-18.2} = .225$$

From Ricker's (1944) table 1, this value of k (Ricker's i) corresponds by interpolation to a total annual mortality rate of 20 per cent per year.

The Error of the Method

The mathematics of the method given above make it necessary to assume, in addition to the matters mentioned on page 191 that (a) all pilchards over

217 mm. in length grow according to the function given in formula (1), and (b) all pilchards reach this length at a given age T. Due to natural variations in growth, actual pilchard populations do not conform strictly to these requirements. To determine the magnitude of the error introduced by this non-conformity, hypothetical populations were constructed, based on the "idealization" of certain pilchard data, and having known mortality rates.

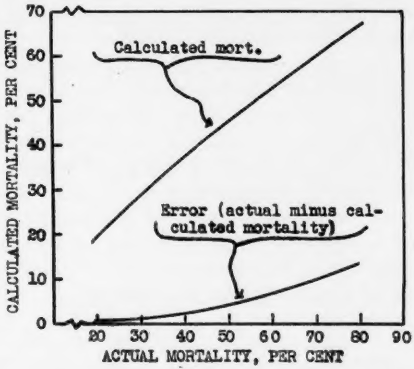

Fig. 3. Relation between actual and calculated mortality for certain hypothetical populations, as explained in text.

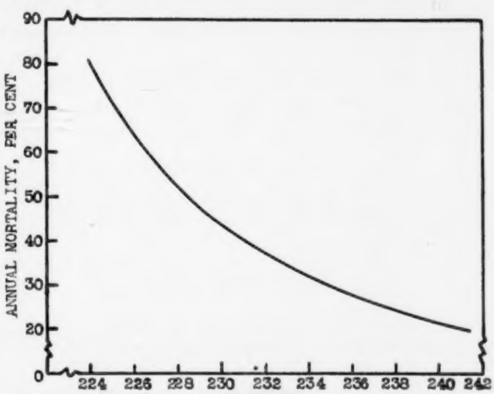

Fig. 4. Relation between average length of the pilchards over 217 mm. in body length and the actual annual mortality rate, for certain hypothetical populations as described in text.

Inspection of the results, given graphically in Figure 3, indicates that at mortality rates of up to about 20 per cent per year the error is negligible, but increases rapidly with increasing mortality rate above 20 per cent. For this reason it is fortunate that other methods are available for the higher mortality rates prevailing under recent levels of exploitation.

To provide a corrected estimate of mortality rates between 20 and 80 per cent per year, the error at each percentage shown in Figure 3 was added to the calculated mortality, and plotted as a function of average length (Fig. 4). On the *x*-axis is given the average length of those fish in the populations which are more than 217 mm. in length. On the *y*-axis are read the corresponding estimates of total mortality rate. Because of the steep slope of the curve at the left end, extreme caution should be used in applying the method where estimated mortalities are greater than 50 per cent.

An additional possible source of error has been suggested to me in correspondence by Dr. W. E. Ricker. This is that the growth curve presented may have been influenced by selection of the commercial fishery against the smaller sizes of fish of each age. Such an influence would apply to the younger ages involved, and if it exists would necessitate selecting a higher "minimum length" when applying the procedure to length frequencies. Examination of such material as is available indicates that this influence is probably very small over the range of sizes (217–280 mm.) covered in the application of the method described above. If serious selection were found within this range, it would be necessary to move the arbitrary minimum above the greatest length at which selection was effective.

Discussion

The method presented in this report should provide a useful tool for estimating mortality rates in seasons prior to the advent of tagging and age determination. Since use of the method presupposes uniform recruitment and mortality rates, length frequencies used in applying it should be averaged for periods long enough (at least four seasons) to smooth out the effect of short-term fluctuations.

Another assumption is that the catch perfectly samples the sizes of fish above the chosen minimum, and the validity of this should be carefully examined in any application of the method.

Acknowledgments

For critical reading of the manuscript of this report, and many helpful suggestions, I am grateful to Drs. Frances N. Clark, John L. Hart, Willis H. Rich and William E. Ricker.

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United States Fish and Wildlife Service, 2725 Montlake Blvd., Seattle, Washington.

The Status of *Lavinia ardesiaca*, a Cyprinid Fish from the Pajaro-Salinas River Basin, California [1]

By Robert R. Miller

THE Pajaro and Salinas rivers form the principal tributaries to Monterey Bay, along the coast of central California. The fish fauna of the Monterey basin has been treated in detail by Snyder (1913), who has shown that the strictly fluvial fishes are all derived from, and mostly identical with, those of the Sacramento River system to the north.

During the routine identification of collections made by my father and me in the Pajaro and Salinas rivers in 1939, I noticed that my fin-ray counts for *Lavinia ardesiaca* Snyder (1913: 58–61, fig. 1), one of the endemic minnows, did not agree with those published by Dr. Snyder. His data showed that *ardesiaca* frequently had 9 dorsal and 9 anal rays, whereas my counts for these fins never fall below 10 (Tables V and VI).

The range of variation given by Snyder (1913: table, page 59) in the dorsal and anal rays seems unusually extended for *ardesiaca,* as compared with *exilicauda.* In the two forms, the dorsal varied from 8 to 12 and 10 to 12, and the anal varied from 8 to 13 and 11 to 13, respectively. This led me to suspect that Snyder's material of *ardesiaca* did not comprise a genetic unit.

In 1941, a preliminary analysis of critical material (kindly collected by R. G. Miller and W. I. Follett and donated to the University of Michigan) disclosed the probable source for Synder's low dorsal and anal ray counts. In those collections, hybrids between the *Lavinia* and another local minnow, *Hesperoleucus symmetricus subditus* [2] Synder (1913: 67–70, fig. 3), were found. As demonstrated herein, the *Hesperoleucus* usually has 8 dorsal and 7 anal rays, in contrast to 10 or 11 dorsal and 11 or 12 anal rays in the *Lavinia,* whereas the number of rays in these fins in the presumed hybrids bridges the gap between those counts (Tables V and VI). The number of gill-rakers is also intermediate (Table VII). Circumstantial evidence for a hybrid interpretation of such intermediates is strong.

This paper presents data showing: (1) that *ardesiaca* is preoccupied by *Lavinia harengus* Girard, described from Monterey; (2) that *harengus* cannot be specifically separated from *Lavinia exilicauda* Baird and Girard; and (3) that *Lavinia* and *Hesperoleucus* hybridize in the Monterey basin.

The genus *Lavinia* (regarded herein as monotypic) is elsewhere known only from the Sacramento River system. The genus *Hesperoleucus* has a somewhat greater range for it is found from the Cuyama River basin (where introduced?), the next river system south of Monterey Bay, northward to the Navarro and Gualala rivers, throughout the Sacramento basin, and in the Warner Lakes drainage of south-eastern Oregon (Snyder, 1913: 63–70; Schultz and DeLacy, 1935: 379). The record for the Cuyama drainage is based on material at the University of Michigan.

In both the original account of *Lavinia harengus* (Girard, 1856: 184),

1 Published by permission of the Secretary of the Smithsonian Institution.

2 Preliminary analysis of the forms of *Hesperoleucus* shows that many, if not all, of those described as species are geographic subspecies of *H. symmetricus* (Baird and Girard).

and in his summary volume (Girard, 1858: 242), reference was made to more than one specimen. However, in the second work only a single specimen, the type (USNM No. 210), was listed, and only this specimen was found in the U. S. National Museum. I have compared this fish with the type of *Lavinia ardesiaca* (USNM No. 74459) and also with the types (USNM No. 207 [3]) of *Lavinia exilicauda* Baird and Girard (in Girard, 1854: 137), and find the type of *harengus* to agree very closely with that of *ardesiaca* despite its poor condition (Table I). The comparatively slender body, rather

TABLE I
COMPARISON OF THE TYPES OF *Lavinia**

Characters	Species *exilicauda*	*harengus*	*ardesiaca*
Body depth into standard length	3.4, 3.4	3.8	3.7
Width of bony interorbital into head length	2.9, 2.9	2.65	2.6
Head width into head length	1.9, 1.9	1.75	1.6
Anal base into pelvic insertion to anal origin	1.1, 1.25	1.6	1.5
Dorsal rays	11, 11	10	10
Anal rays	14, 13	11	11
Standard length in mm. (approximate)	230, 240	217	229

* *Lavinia crassicauda* Baird and Girard belongs to the genus *Gila*, and *Lavinia conformis* Baird and Girard is a synonym of *L. crassicauda* (Miller, 1945: 105).

gibbous head, and smaller dorsal and anal fins are characters shared by *harengus* and *ardesiaca*. All specimens of *exilicauda* of a size comparable with that of the type of *harengus* which I have examined are much deeper-bodied. As shown in Table II, body depth is the principal character used to separate *harengus* and *exilicauda*.

TABLE II
GREATEST DEPTH OF BODY STEPPED INTO THE STANDARD LENGH IN TWO SUBSPECIES OF *Lavinia exilicauda*

Subspecies	Ratio of body depth to standard length 3.2	3.3	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	No.	Ave.
L. e. exilicauda	2	8	6	11	7	1	1	..	..	..	..	36	3.5
L. e. harengus	..	..	..	2	5	7	7	6	3	4	2	36	3.8

Although *harengus* and *exilicauda* are very similar and have been synonymyzed (Jordan, Evermann, and Clark, 1930: 113), it seems best to retain *harengus* as a subspecies. The slenderer body affords a ready means of distinguishing it from *exilicauda*, for the body depth stepped into the standard length usually gives ratios varying from 3.6 to 3.9 in *harengus* and 3.3 to 3.6 in *exilicauda* (Table II). Based on a line of separation between 3.6 and 3.7, 94 per cent of the specimens of *exilicauda* and 81 per cent of those of *harengus* are identifiable. However, in specimens smaller than 80 or 90 mm. in standard length the difference is much less reliable and specimens less than 72 mm. long were not used in this comparison. Moreover, examination

[3] Jordan and Evermann (1896: 209) erred in stating that USNM No. 209 also was type material. The two specimens in that jar were collected by Newberry in the San Joaquin River, whereas the types of *exilicauda* were collected by Heermann in the Sacramento River.

of additional material of *exilicauda,* particularly from the streams tributary to San Francisco Bay and vicinity, is needed to determine the validity of the difference shown in Table II.

That *Lavinia e. exilicauda* and *Lavinia e. harengus* cannot be distinguished specifically by the number of dorsal or anal fin-rays is clearly demonstrated in Tables III and IV. Despite the significantly fewer rays in *harengus,* the amount of overlap in these counts is too great to permit even subspecific separation.

TABLE III

FREQUENCY OF DORSAL FIN-RAYS IN *Lavinia exilicauda*

Subspecies and Locality	Museum and Cat. No.		Dorsal Rays				No.	Ave.
			10	11	12	13		
L. e. exilicauda								
Kern River, near Bakersfield	UMMZ	124830	4	23	2	1	30	11.00
Kern River, near Oildale	UMMZ	131769	1	9	2	..	12	11.08
Miles Creek, near Mariposa	UMMZ	131621	8	15	..	..	23	10.65
Dutchman's Creek, near Merced	UMMZ	131612	20	32	1	..	53	10.64
Kings River, Centerville	USNM	61197	4	17	..	..	21	10.81
Merced River, Livingstone	USNM	126926	1	9	1	..	11	11.00
Sacramento River, Jacinto	USNM	58465	1	8	..	..	9	10.89
Marsh Creek, Contra Costa Co.	UMMZ	133178	4	83	13	..	100	11.09
Antelope Creek, Placer Co.	USNM	58475	2	7	..	..	9	10.78
Suisun Creek, Napa Co.	UMMZ	131516	8	..	..	..	8	10.00
L. e. harengus								
Pajaro River, near Watsonville	UMMZ	133213	28	31	1	..	60	10.55
Salinas River, near Salinas	USNM	75362	16	7	..	1	24	10.42
Pajaro River, Watsonville	SNHM	22490	9	2	..	..	11	10.18
Pajaro River, near Watsonville	*USNM	74459	1	..	..	..	1	....
Pajaro River, above Watsonville	USNM	75358	10	12	..	..	22	10.55
Pajaro River, San Benito R. mouth	USNM	75357	1	1	..	..	2	....
Salinas River, near Gonzales	USNM	75360	18	2	..	..	20	10.10
Salinas River, near King City	UMMZ	133202	62	50	1	..	113	10.46
Nacimiento River, near mouth	UMMZ	137636	11	5	..	..	16	10.31
San Juan Creek, near mouth	UMMZ	137602	2	7	..	..	9	10.78
Salinas River, near Paso Robles	UMMZ	133196	12	12	..	..	24	10.50
Upper tributary to Salinas River	UMMZ	94207	9	12	..	..	21	10.57
Totals								
L. e. exilicauda			53	203	19	1	276	10.88
L. e. harengus			179	141	2	1	323	10.46
Species total			232	344	21	2	599	10.65

* Holotype of *Lavinia ardesiaca.*

To determine whether *Lavinia ardesiaca* was based in part on hybrids, I examined all of Snyder's types amounting to 215 specimens (214 cotypes and the type).[4] Of these, more than half appear to have mixed blood (Tables V to VII). The specimens secured from the Pajaro River at Watsonville (USNM Nos. 75356, 75361, and 75363) were all collected by Gilbert, Osgood, and Snyder on October 16, 1896, and therefore represent a single collection. Although it may be shown that a few of these 105 specimens are true *Lavinia,* I regard them all as hybrids between *Lavinia exilicauda harengus* and *Hesperoleucus symmetricus subditus,* pending a detailed analysis of their characters. The only other lot which I interpret as having mixed blood are cotypes (USNM No. 75359) secured in the Pajaro River at Sargent on October 17, 1896, by Gilbert, Osgood, and Snyder. A few of these may

4 After this was written I learned that there are 35 additional cotypes at Stanford University.

be pure *Lavinia* and one of them (now bearing USNM No. 131363) is regarded as a *Hesperoleucus* (dorsal 8, anal 7, gill-rakers 8). It is significant that the two collections containing the presumed hybrids were secured on successive days of the same year, for samples taken in later years from one of these localities (Watsonville) exhibit no atypical specimens (Tables V to VII). When the 132 questionable specimens are analyzed separately from the other 316 specimens studied, they stand apart significantly in number of dorsal and anal rays (Tables V and VI) and in gill-raker counts (Table VII), and that their values for these enumerations lie interjacent between *Hesperoleucus s. subditus* and *Lavinia e. harengus*.

Table IV

Frequency of Anal Fin-rays in *Lavinia exilicauda*

Subspecies and Locality	Museum and Cat. No.	Anal Rays 10	11	12	13	14	15	No.	Ave.
L. e. exilicauda									
Kern River, near Bakersfield	UMMZ 124830	..	1	21	7	1	..	30	12.27
Kern River, near Oildale	UMMZ 131769	..	..	6	4	2	..	12	12.67
Miles Creek, near Mariposa	UMMZ 131621	..	1	14	8	..	..	23	12.30
Dutchman's Creek, near Merced	UMMZ 131612	1	12	32	8	..	..	53	11.89
Kings River, Centerville	USNM 61197	..	3	10	8	..	..	21	12.24
Merced River, Livingstone	USNM 126926	..	..	7	4	..	..	11	12.36
Sacramento River, Jacinto	USNM 58465	..	1	1	7	..	..	9	12.67
Marsh Creek, Contra Costa Co.	UMMZ 133178	..	2	49	43	4	2	100	12.55
Antelope Creek, Placer Co.	USNM 58475	..	..	4	5	..	..	9	12.55
Suisun Creek, Napa Co.	UMMZ 131516	..	3	4	1	..	..	8	11.75
L. e. harengus									
Pajaro River, near Watsonville	UMMZ 133213	1	21	29	9	..	..	60	11.77
Salinas River, near Salinas	USNM 75362	..	7	16	1	..	..	24	11.75
Pajaro River, Watsonville	SNHM 22490	1	7	3	..	..	..	11	11.18
Pajaro River, near Watsonville	*USNM 74459	..	1	..	..	..	..	1	....
Pajaro River, above Watsonville	USNM 75358	2	9	10	1	..	..	22	11.45
Pajaro River, San Benito R. mouth	USNM 75357	..	..	2	..	..	..	2	....
Salinas River, near Gonzales	USNM 75360	..	11	9	..	..	..	20	11.45
Salinas River, near King City	UMMZ 133202	4	50	51	8	..	..	113	11.56
Nacimiento River, near mouth	UMMZ 137636	..	9	6	1	..	..	16	11.50
San Juan Creek, near mouth	UMMZ 137602	..	4	5	..	..	..	9	11.55
Salinas R., near Paso Robles	UMMZ 133196	..	9	13	2	..	..	24	11.71
Upper tributary to Salinas River	UMMZ 94207	..	6	13	2	..	..	21	11.81
Totals									
L. e. exilicauda		1	23	148	95	7	2	276	12.33
L. e. harengus		8	134	157	24	..	..	323	11.61
Species total		9	157	305	119	7	2	599	11.89

* Holotype of *Lavinia ardesiaca*.

Evidence that the two hybrid lots are not strictly comparable is shown by the consistently higher averages of the lots from Watsonville as compared with the sample from Sargent. On the theory that fish hybrids tend to be intermediate between the parental forms (Hubbs, Hubbs, and Johnson, 1943, and references cited therein), ideal hybrids between the Monterey *Hesperoleucus* and *Lavinia* would give the following approximate average values: dorsal rays, 9.3; anal rays, 9.4; and gill-rakers, 15.0. The 27 specimens from Sargent gave values of 9.2, 9.5, and 14.6 for these counts, whereas the combined data for the Watsonville material gave the corresponding values of

9.6, 10.0, and 15.9 (computed from Tables V to VII). The values for the Sargent hybrids fall remarkably close to those for the theoretical hybrids. The higher values for the Watsonville material, which was collected where no specimens of *Hesperoleucus* have been taken (see table, page 55, in Snyder, 1913), may have resulted from backcrossing between this population and *Lavinia,* which is abundant in this section of the river.

TABLE V

FREQUENCY OF DORSAL FIN-RAYS IN *Hesperoleucus symmetricus subditus*, HYBRIDS, AND *Lavinia exilicauda harengus*

Form and Locality	Museum and Cat. No.	Dorsal Rays 7	8	9	10	11	12	13	No.	Ave.
Hesperoleucus s. subditus										
Salinas R., near Bradley	UMMZ 94200	..	87	1	..	..	..	..	88	8.01
Arroyo Seco Creek	*USNM 75349	..	36	1	..	..	..	..	37	8.03
Nacimiento R.	UMMZ 137635	..	33	1	..	..	..	..	34	8.03
Hames Valley Creek	UMMZ 137627	3	96	1	..	..	..	..	100	7.98
San Antonio R.	UMMZ 137614	4	95	1	..	..	..	..	100	7.97
Llagas Creek, Pajaro basin	UMMZ 63414	..	98	2	..	..	..	..	100	8.02
Llagas Creek, Pajaro basin	*USNM 75343	..	9	1	..	..	..	..	10	8.10
San Benito R.	*USNM 75347	..	29	1	..	..	..	..	30	8.03
Hesperoleucus x *Lavinia*										
Pajaro R., Watsonville	†USNM 75356	..	..	16	20	2	..	..	38	9.63
Pajaro R., Watsonville	†USNM 75361	1‡	..	16	22	..	..	..	39	9.51
Pajaro R., Watsonville	†USNM 75363	..	..	11	17	..	..	..	28	9.61
Pajaro R., Sargent	†USNM 75359	..	4	16	6	1	..	..	27	9.15
Lavinia exilicauda harengus										
Pajaro R., Watsonville	†SNHM 22490	..	..	..	9	2	..	..	11	10.18
Pajaro R., Watsonville	†USNM 75683	..	..	..	2	1	..	..	3	....
Pajaro R., near Watsonville	UMMZ 133213	..	..	..	28	31	1	..	60	10.55
Pajaro R., 3 mi. above Watsonville	†USNM 75358	..	..	..	10	12	..	..	22	10.55
Pajaro R., San Benito R. mouth	†USNM 75357	..	..	..	1	1	..	..	2	....
Salinas R., near Gonzales	†USNM 75360	..	..	..	18	2	..	..	20	10.10
Salinas R., near Salinas	†USNM 75362	..	..	..	16	7	..	1	24	10.42
Salinas R., near King City	UMMZ 133202	..	..	..	62	50	1	..	113	10.46
Salinas R., near Paso Robles	UMMZ 133196	..	..	..	12	12	..	..	24	10.50
Nacimiento R.	UMMZ 137636	..	..	..	11	5	..	..	16	10.31
Upper trib. Salinas R.	UMMZ 94207	..	..	..	9	12	..	..	21	10.57
Totals										
Hesperoleucus		7	483	9	..	..	..	..	499	8.00
Hybrids		1	4	59	65	3	..	..	132	9.49
Lavinia		..	..	..	178	135	2	1	316	10.45

* Cotypes (= paratypes) of *Hesperoleucus subditus.*
† Cotypes (= paratypes) of *Lavinia ardesiaca.*
‡ Anal rays were 10 in this fish.

As Snyder (1913: 60–61) pointed out, *Lavinia* inhabits the quieter waters of the lower stream courses and is only seldom found with *Hesperoleucus,* the common cyprinid of the higher tributaries. In the few places where their ranges have been found to overlap, however, these two forms appear to have engaged in mass hybridization.

The only other cyprinids known from the well-worked Pajaro-Salinas basin are the blackfish, *Orthodon microlepidotus* (Ayres), the Sacramento pike or squawfish, *Ptychocheilus grandis* (Ayres), and the western dace,

Rhinichthys osculus (Girard). The questionable lots interpreted as hybrids obviously cannot be identified with any of these species.

TABLE VI

FREQUENCY OF ANAL FIN-RAYS IN *Hesperoleucus symmetricus subditus*, HYBRIDS, AND *Lavinia exilicauda harengus*

Form and Locality	Museum and Cat. No.	Anal Rays								No.	Ave.
		6	7	8	9	10	11	12	13		
Hesperoleucus s. subditus											
Salinas R., near Bradley	UMMZ 94200	..	70	18	..	..	..	..	..	88	7.20
Arroyo Seco Creek	*USNM 75349	..	28	9	..	..	..	..	..	37	7.24
Nacimiento R.	UMMZ 137635	..	22	12	..	..	..	..	..	34	7.35
Hames Valley Creek	UMMZ 137627	2	81	17	..	..	..	..	..	100	7.15
San Antonio R.	UMMZ 137014	..	86	14	..	..	..	..	..	100	7.14
Llagas Creek, Pajaro basin	UMMZ 63414	..	79	21	..	..	..	..	..	100	7.21
Llagas Creek, Pajaro basin	*USNM 75343	..	10	..	..	..	..	..	..	10	7.00
San Benito R.	*USNM 75347	..	25	4	1	..	..	..	..	30	7.20
Hesperoleucus x *Lavinia*											
Pajaro R., Watsonville	†USNM 75356	..	1	..	10	19	5	3	..	38	9.95
Pajaro R., Watsonville	†USNM 75361	..	..	1	8	27	1	2	..	39	9.87
Pajaro R., Watsonville	†USNM 75363	..	..	..	5	17	4	2	..	28	10.11
Pajaro R., Sargent	†USNM 75359	..	..	4	9	11	3	..	..	27	9.48
Lavinia exilicauda harengus											
Pajaro R., Watsonville	†SNHM 22490	..	..	..	..	1	7	3	..	11	11.18
Pajaro R., Watsonville	†USNM 75683	..	..	..	..	..	..	3	..	3	....
Pajaro R., near Watsonville	UMMZ 133213	..	..	..	..	1	21	29	9	60	11.77
Pajaro R., 3 mi. above Watsonville	†USNM 75358	..	..	..	..	2	9	10	1	22	11.45
Pajaro R., San Benito R. mouth	†USNM 75357	..	..	..	..	..	..	2	..	2	....
Salinas R., near Gonzales	†USNM 75360	..	..	..	..	..	11	9	..	20	11.45
Salinas R., near Salinas	†USNM 75362	..	..	..	..	..	7	16	1	24	11.75
Salinas R., near King City	UMMZ 133202	..	..	..	..	4	50	51	8	113	11.56
Salinas R., near Paso Robles	UMMZ 133196	..	..	..	..	..	9	13	2	24	11.71
Nacimiento R.	UMMZ 137636	..	..	..	..	..	9	6	1	16	11.50
Upper trib. Salinas R.	UMMZ 94207	..	..	..	..	..	6	13	2	21	11.81
Totals											
Hesperoleucus		2	401	95	1	..	..	..	..	499	7.19
Hybrids		..	1	5	32	74	13	7	..	132	9.86
Lavinia		..	..	..	..	8	129	155	24	316	11.62

* Cotypes (= paratypes) of *Hesperoleucus subditus*.
† Cotypes (= paratypes) of *Lavinia ardesiaca*.

Dr. Reeve M. Bailey, Associate Curator of Fishes at the University of Michigan, kindly loaned critical material and supplied catalogue numbers for several lots. Dr. George S. Myers and Miss Margaret Storey, of Stanford University, provided pertinent data and generously allowed me to examine the Stanford collections in 1942. The following abbreviations are used in Tables III to VII: USNM=U. S. National Museum; UMMZ=University of Michigan Museum of Zoology; and SNHM=Stanford Natural History Museum.

SUMMARY

Lavinia ardesiaca, based in part upon intergeneric hybrids, is shown to be preoccupied by *Lavinia harengus*. That species is regarded as being only

TABLE VII

FREQUENCY OF GILL-RAKERS IN *Hesperoleucus symmetricus subditus*, HYBRIDS, AND *Lavinia exilicauda harengus*

Form and Locality	Museum and Cat. No.		Number of Gill-rakers 7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	No.	Ave.
Hesperoleucus s. subditus																							
Salinas R., near Bradley	UMMZ	94200	..	3	19	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	25	9.00
Arroyo Seco Creek	*USNM	75349	1	5	20	4	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	32	9.03
San Benito R.	*USNM	75347	..	6	18	5	1	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	30	9.03
Llagas Creek	*USNM	75343	2	2	4	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	10	8.60
Hesperoleucus x *Lavinia*																							
Pajaro R., Watsonville	†USNM	75356	..	..	..	..	..	2	1	7	5	7	8	4	2	1	1	..	..	..	..	..	38	16.03
Pajaro R., Watsonville	†USNM	75361	..	..	..	..	..	..	2	5	8	14	1	5	4	..	..	..	..	..	..	..	39	15.97
Pajaro R., Watsonville	†USNM	75363	..	..	..	..	..	..	3	6	5	4	8	1	..	1	..	..	..	..	..	..	28	15.57
Pajaro R., Sargent	†USNM	75359	..	..	..	2	2	1	3	6	6	2	4	..	1	..	..	..	..	..	..	..	27	14.55
Lavinia exilicauda harengus																							
Pajaro R., near Watsonville	UMMZ	133213	..	..	..	..	..	..	..	..	..	..	..	1	3	4	5	7	6	2	1	1	30	21.70
Pajaro R., 3 mi. above Watsonville	†USNM	75358	..	..	..	..	..	..	..	..	..	..	..	1	2	3	7	3	2	1	..	..	19	21.00
Pajaro R., San Benito R. mouth	†USNM	75357	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	2	..	2	...
Salinas R., near King City	UMMZ	133202	..	..	..	..	..	..	..	..	..	..	..	2	4	6	6	3	2	..	..	..	23	20.43
Salinas R., near Paso Robles	UMMZ	133196	..	..	..	..	..	..	..	..	..	..	2	2	4	5	6	4	..	..	..	..	23	20.00
Totals																							
Hesperoleucus			3	16	61	14	3	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	97	8.98
Hybrids			..	..	..	2	2	3	9	24	24	27	21	10	7	2	1	..	..	..	..	..	132	15.56
Lavinia			..	..	..	..	..	..	..	..	..	..	2	6	13	18	24	17	10	3	3	1	97	20.93

* Cotypes (= paratypes) of *Hesperoleucus subditus*.
† Cotypes (= paratypes) of *Lavinia ardesiaca*.

subspecifically separable from *Lavinia exilicauda*. The scientific name of the Monterey form therefore becomes *Lavinia exilicauda harengus* Girard.

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Notes on the Osteology of Typhlopid Snakes

By J. A. TIHEN

INSOFAR as I am aware, the only published comments on the osteology of any of the typhlopid snakes, with the exception of the genus *Typhlops* itself, are those of Dunn (1941) on *Anomalepis aspinosus* and those of Dunn and Tihen (1944) on *Liotyphlops albirostris*. The specimen on which Dunn's report was based had been somewhat mutilated, and certain of the relationships were consequently obscure. Through the courtesy of Mr. Karl P. Schmidt, of the Chicago Natural History Museum, I have recently been permitted to examine a cleared and stained specimen of *Anomalepis dentatus* (=*A. mexicanus?*) from Panama. Although the results of the clearing process were unsatisfactory, and many details therefore not discernible, certain

relationships can be noted in it that were not observable on Dunn's specimen, and certain comments can be made on comparisons between this specimen and other forms in the family Typhlopidae whose osteology is known.

Vertebrae and Ribs.—Whether or not the atlas is divided ventrally is uncertain; it is not divided dorsally. The presence or absence of hypapophyses on the anterior vertebrae cannot be certainly determined. There is a total of 202 vertebrae, as follows: atlas, axis, 188 bearing unforked ribs, 5 bearing distally forked ribs, and 7 without ribs.

Cranium.—The premaxilla is single and edentulous; it is excluded from view in the dorsal aspect of the cranium. The nasals are fused into a single large bone that excludes the prefrontals (as well as the premaxilla) from view in the dorsal aspect. The frontals are paired, the parietal single; there is a marked lateral projection, involving the postero-lateral angle of the frontal and the antero-lateral angle of the parietal, for articulation with the supraorbital. The supraoccipital is broad and unpaired; its exact relations with the foramen magnum are uncertain, but it is clear that the contact or separation, as the case may be, is narrow. The exoccipitals and the otic elements are probably independent from each other, although this feature is not entirely clear in the specimen at hand. Immediately anterior to the sphenoid a narrow median suture can be observed, but the complete outline of the bones that meet to form this suture, and of the surrounding bones, is indiscernible. The suture may possibly represent a close approximation of two palatines; its position and extent more likely indicate the presence of the elements tentatively identified by Dunn and Tihen as the laterosphenoids in *Liotyphlops albirostris*. The basioccipital and the sphenoid appear as in that form. No further details concerning the bones of the ventral surface of the cranium can be distinguished.

Orbital Bones and Upper Jaw Mechanism.—There are present a supraorbital and a postorbital nearly identical with those described by Dunn in *A. aspinosus;* these differ from the orbital bones of *Liotyphlops* only in the greater size, more complex shape, and more longitudinal orientation of the postorbital. The maxilla, which bears either four or five teeth, is in pivotal contact dorsally with the anterior end of the supraorbital, as described in *Liotyphlops*. The pterygoid is a long bone, unattached to the skull; near its anterior end it connects with the independent ectopterygoid, which abuts against the posterior border of the maxilla. This arrangement is identical with that in *Liotyphlops*, but whether an independent palatine exists cannot be certainly determined.

Quadrate and Lower Jaw.—The lower jaw, as in *Liotyphlops* and *A. aspinosus*, consists of a dentary, coronoid, angular and "compound bone." In the present specimen, in contrast to those forms, it also appears that the antero-dorsal portion of the compound bone constitutes a separate element, presumably the surangular; confirmation of this point is needed from specimens more successfully cleared. No independent splenial is present. The compound bone bears a retroarticular process longer than the quadrate, and there is a single tooth at the anterior tip of the dentary.

Pelvic Girdle.—No remnants of the pelvic girdle are present.

Hyobranchial (?) Apparatus.—In *Liotyphlops* an element was described which I presumed at the time to represent a vestigial pectoral girdle.

This consisted of a very thin W-shaped structure shortly posterior to the posterior border of the skull; also present was a small V-shaped structure at the anterior end of the trachea, this latter being considered to represent the hyobranchial apparatus. I have subsequently (cf. below) come to the conclusion that these interpretations may well be erroneous, and that the alternative possibility, suggested in my paper with E. R. Dunn as being less likely, is correct, i.e., that the anterior V-shaped structure represents modified laryngeal cartilages, while the posterior element represents the true hyobranchial apparatus. Whatever the true designation of these two structures may be, the same condition appears in the present specimen as was described in *Liotyphlops*. In the present case the W-shaped structure is somewhat more anterior in position, the transverse median portion being slightly anterior to the posterior border of the skull. Also the lateral limbs of this structure are only about half the length of the medial longitudinal limbs, as compared with an approximately equal length in *Liotyphlops*. Whether this structure actually represents a pectoral girdle, or represents a hyobranchial apparatus, its shape is so unusual as to be worthy of comment.

Comparisons

The osteology of *Helminthophis* is entirely unknown, but since that genus appears to be intermediate between *Anomalepis* and *Liotyphlops* in other characters, it seems reasonable to assume that most if not all of the osteological characters common to the last two genera are also shared by *Helminthophis*. Our knowledge of the skeletal structure of the genus *Typhlops* is also regrettably deficient in certain respects; although the osteology of several species has been described, these descriptions were based for the most part on dry specimens; certain of the smaller bones could therefore easily have been lost, or their relationships so distorted as to render these descriptions unreliable in many respects. Nevertheless, certain facts merit discussion.

Although there are important resemblances among the genera *Anomalepis, Liotyphlops,* and *Typhlops,* as pointed out in the articles by Dunn and by Dunn and Tihen, there are also certain features in which *Anomalepis* and *Liotyphlops* resemble each other but differ from *Typhlops* (and also from *Leptotyphlops*). These features have, in my opinion, been insufficiently emphasized.

Taylor has recently (1939) proposed a family Anomalepidae, to contain the single genus *Anomalepis*. Subsequent papers, notably that of Dunn, have in large part been devoted to showing that there is a closer resemblance between *Anomalepis* and the remainder of the Typhlopidae than exists between that genus and the Leptotyphlopidae. I believe there has been a tendency to disregard or to minimize the importance of certain features in which the *Anomalepis-Liotyphlops* complex differs from both *Typhlops* and *Leptotyphlops*. I agree with Dunn that Taylor's proposal of a family Anomalepidae was premature, and that the genera *Anomalepis* and *Liotyphlops,* probably also *Helminthophis,* are closely related; therefore that recognition of a family Anomalepidae containing the single genus *Anomalepis* is unwarranted. Nevertheless, the possibility that the *Anomalepis-Helminthophis-Liotyphlops* complex does constitute a family distinct from the

Typhlopidae cannot be entirely disregarded, nor can the more likely possibility that the members of this complex constitute a group which, though closely related to *Typhlops,* should be considered to represent a subfamily of the family Typhlopidae. The present paucity of information concerning most of the forms forbids any final decision at present, but I would like at this time to call attention to the salient features, which, I believe, must be taken into account in any consideration of the interrelationships among these various forms.

Mr. Leonard Laufe, of the Department of Zoology of the University of Rochester, who is conducting a study of the interrelationships within the genus *Leptotyphlops,* has in his possession a number of stained and cleared specimens of that genus; these he has very courteously allowed me to examine. The remarks concerning this group are based in large part on those specimens. I wish to express my gratitude for his generosity in allowing publication of such data as are deemed pertinent to the present discussion. I also wish to acknowledge the helpful criticisms of Dr. E. R. Dunn of Haverford College and of Drs. Hobart M. Smith and S. C. Bishop of the University of Rochester.

The accompanying table shows in condensed form a comparison of certain features in *Leptotyphlops, Typhlops* and the *Anomalepis-Liotyphlops* complex. A discussion of these features follows in the text.

TABLE I

COMPARISON OF CERTAIN FEATURES IN *Leptotyphlops, Typhlops, Anomalepis* AND *Liotyphlops*

	Leptotyphlops	*Typhlops*	*Anomalepis* and *Liotyphlops*
1. Maxilla	a. Edentulous	Toothed	Toothed
	b. Contacts premaxilla and prefrontal	Does not contact premaxilla or prefrontal	Does not contact premaxilla or prefrontal
	c. Immovable	Movable	Movable
	d. Does not pivot on supraorbital	Does not pivot on supraorbital	Pivots on supraorbital
2. Orbitals	None	None or quite small	Present, large
3. "Laterosphenoids"	Absent	Apparently absent	Present in some, possibly all
4. Splenial	Present	Present	Absent
5. Dentary	Teeth numerous	Teeth absent	One tooth
6. Compound bone	Short and high	Long and narrow	Long and narrow
7. Pelvic girdle	Usually present and well developed; occasionally absent	Present but reduced	Absent
8. Hyoid (?)	a. Y-shaped	Y-shaped	W-shaped
	b. Deep	Deep	Superficial
9. Quadrate	Relatively long	Short and flat	Short and flat

In connection with the condensed comparisons shown in this table, certain features concerning the groups in question can be easily discerned.

Anomalepis and *Liotyphlops* agree with *Typhlops,* not with *Leptotyphlops,* in five points (1a, 1b, 1c, 6 and 9).

Anomalepis and *Liotyphlops* are not strictly comparable to *Leptotyphlops* in any of the features considered.

Anomalepis and *Liotyphlops* agree with each other, differing from both *Typhlops* and *Leptotyphlops,* in six points (1d, 3, 4, 7, 8a, and 8b).

There is some disagreement among all three groups in two respects (2 and 5).

Of the characters considered, the Leptotyphlopidae are unique in six

(possibly seven, including 2) features; the Typhlopidae are unique in only one (possibly two, including 2); and the *Anomalepis-Liotyphlops* complex is unique in seven (possibly eight, including 2).

Therefore, despite the greater resemblance to *Typhlops* than to *Leptotyphlops,* it would seem that, because of the large number of unique characters, the anomalepids (extended as suggested above) are worthy of consideration as a valid and recognizable family or subfamily group.

Such a summary and condensation of salient features may distort the true picture of the relationships concerned, and further discussion of the features mentioned in the table is desirable. In the following paragraphs the *Anomalepis-Liotyphlops* complex will be referred to as the "anomalepids," and *Typhlops* as the "typhlopids"; the use of these terms is informal and does not imply acceptance of such a family classification.

The characters included under 1b, 1c, 1d and 2 are, by their very nature, closely interrelated; e.g., it is obviously impossible for the maxilla to pivot on the supraorbital when no supraorbital is present. As regards the presence or absence of orbital bones, if these elements are not present in *Typhlops* then the anomalepids are unique in their possession; if they are present in *Typhlops* (c.f. Mahendra 1936), they are quite small, and certainly non-functional as regards the kinetics of the upper jaw. I can find no traces of the orbital bones in a cleared and stained specimen of *Typhlops braminus* at hand. It is questionable whether such small non-functional elements are more closely comparable to a complete absence (as in Leptotyphlopidae) or to a condition in which these elements are large and functional (as in anomalepids). The relationships of the maxilla to the skull proper in typhlopids is, however, essentially similar to that in the anomalepids, the chief difference being that the relationship with the supraorbital was necessarily lost when that element was lost.

The distribution of the "laterosphenoids" throughout the various groups must be more carefully studied. Present indications are that this element is present in the anomalepids, absent in other groups; if this is true, it would seem to constitute a major point of distinction.

Presence or absence of the splenial would appear to be a minor character, but the phylogenetic importance of a character can be determined only by its extent and constancy. To the best of present knowledge, the splenial is present in the blind burrowing snakes except in the anomalepids, in which it appears to be absent.

The presence of a single tooth on the tip of the dentary might likewise be considered unimportant, except for the fact that, according to the figures of Haas (1930), the dentary itself is strongly reduced in *Typhlops,* while in *Leptotyphlops* and the anomalepids this bone is well developed and moderately extensive, even though in the latter the extent of the dentition is noticeably reduced.

Characters 6 and 9 in the table have also been correlated with each other. It must not be overlooked that the quadrate is relatively long in *Leptotyphlops,* relatively short in typhlopids and anomalepids, and that the compound bone bears a distinct retroarticular process in the latter two groups, not in the former. However, any statements concerning the relative length

of the quadrate as compared to the retroarticular process, or the greater length of the compound bone anterior to the articulation point in typhlopids and anomalepids, must be examined more fully, with emphasis upon objective measurements, before they can be completely accepted.

The pelvic girdle has been thought to be universally present in the Leptotyphlopidae; this is apparently true of most of the group, but not of all (oral communication from Mr. Laufe). Nevertheless, its presence or absence in members of that family does not detract from the significance of the fact that it is, so far as is known, present in all typhlopids, while no vestige has been discovered in the anomalepids.

The tentative conclusion that the "pectoral girdle," which I described in *Liotyphlops,* actually represents the hyobranchial apparatus, and that the "hyoid" described in the same paper comprises modified tracheal or laryngeal cartilages, is based on the subsequent examination of several cleared and stained specimens of *Leptotyphlops* and one of *Typhlops braminus.* In all of these a large, typically hyoid-shaped structure is present well posterior to the skull, as well as a small similarly-shaped structure at the anterior end of the trachea. This posterior structure in these forms would seem to be the same as the hyoid of higher snakes, and also the same as the W-shaped structure of the anomalepids. In most snakes this structure is superficial in position, although it is possible that a deeper situation may occur in a few of the higher snakes. It is certainly true that, of the specimens examined, it is deep in all Leptotyphlopidae and typhlopids, superficial in all anomalepids. If this structure in the anomalepids represents a hyobranchial apparatus, its position and unique shape constitute important characteristics to be considered in any discussion of relationships. If, on the other hand, it should prove in that group to represent a pectoral girdle, its importance is even more obvious.

In addition to the features considered in the above table and discussion, others of an apparently more minor nature might be taken into account. The reports by Dunn and by Dunn and Tihen have laid some emphasis on the possession of forked posterior ribs in *Typhlops, Anomalepis* and *Liotyphlops;* such ribs are also regularly present in *Leptotyphlops,* although they are greatly reduced in some African forms. The possession of a surangular may be unique to one form of the anomalepids, that of a tabulare to another (Brock, 1932, reports a tabulare in *Leptotyphlops nigricans;* this observation has not been confirmed by either Mr. Laufe or myself in any other member of the genus). It also seems possible from evidence presented previously that the anomalepids are unique in the possession of laterosphenoids. If this should be found to hold constant, it would be an important point of characterization of the group.

The presence of independent palatines and of independent ectopterygoids abutting against the maxillae may likewise be limited to the anomalepids. In *Typhlops* these elements appear to be fused, if both are actually present. In *Leptotyphlops* the palatine is present, as well as an independent ectopterygoid of varying extent; but the latter, even when well developed, does not bear any kinetic relationship to the maxilla.

The great expansion of the nasals, excluding both the prefontals and

the premaxilla from view in the dorsal aspect of the skull, may be confined to the anomalepids. It is not, however, completely characteristic of that group, since this condition does not exist in *A. aspinosus*.

In summary, it can be stated that, although the genera *Anomalepis* and *Liotyphlops* resemble the genus *Typhlops* much more strongly than they do the genus *Leptotyphlops*, and although they resemble that genus in many characters that seem basically important, they are unique in so many respects (in which they resemble each other) that recognition of the complex comprising these two genera and *Helminthophis* as a distinct taxonomic unit seems desirable. In view of the demonstrably much closer relationship of this complex to *Typhlops* than to *Leptotyphlops*, recognition of three equivalent families of blind snakes is not warranted. Recognition of this complex as a subfamily Anomalepinae of the family Typhlopidae does, on the other hand, appear to me desirable. This subfamily Anomalepinae would include the genera *Anomalepis*, *Helminthophis* and *Liotyphlops*. The remaining subfamily, Typhlopinae, would include only *Typhlops* and perhaps *Typhlophis*. The affinities of the latter must remain for the present uncertain, and further knowledge concerning all of the forms involved is highly desirable.

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Department of Zoology, University of Rochester, Rochester, New York.

Herpetological Notes from Panama

By Paul L. Swanson

BETWEEN August, 1942, and July, 1944, the writer collected herpetological specimens in Panama, mostly from the regions of Pacora, La Chorrera and the Canal Zone. These include one species of caecilian, fourteen of frogs and toads, thirteen of lizards, twenty-five of snakes, two crocodilians, and one turtle. The collection was presented to the Academy of Natural Sciences of Philadelphia and to the Carnegie Museum, and identifications were by E. R. Dunn and M. Graham Netting.

APODA

Caecilia ochrocephala Cope.—This worm-like amphibian is sometimes seen after a heavy rain. One specimen was taken crossing a road near Pacora, another on a putting green at the Ft. Davis golf course. Salvadorean laborers called it "angui" (eel?) "conchagal" and "tepelguba." They agreed that it was dangerous to man in that it would crawl up the rectum while its victim was defecating.

SALIENTIA

Bufo haematiticus Cope.—A number of specimens were taken, all from the forests on the Pacific slope, from mountains to tidewater, in the vicinity of Pacora.

Bufo marinus (Linnaeus).—Common on both slopes. Heard them calling on January 13. Many are hosts to ticks.

Bufo typhonius (Linnaeus).—A forest inhabitant. One specimen from the Atlantic slope near Maria Chiquita, others from the Pacific slope at Chorrera Falls, and hills north of Pacora.

Eleutherodactylus fitzingeri (Schmidt).—This species was taken from the edges of the Tacumen, Tatare and Caimito rivers on the Pacific slope. On January 6, 1944, at Chorrera Falls I heard a number of them calling as I was fishing. The call sounded like sand or grit in a casting reel, which I thought it was at first. They were in small pools among the rocks, which also contained tadpoles and mosquito larvae.

Engystomops pustulosus (Cope).—Very common on both slopes, being the most commonly heard species in the Canal Zone and adjacent areas of Panama. Dunn describes the call as "wheenk" or "wheu-ak-ak" which is perhaps as close as one can come to spelling it. To me it sounds like the noise made by one walking in corduroy trousers. I asked an imaginative friend to describe the sound: "like a stone hitting a tight wire," which I thought apt. I have heard it calling practically all through the rainy season.

Leptodactylus bolivianus Boulenger.—One from near Ft. Gulick and others from the vicinity of Pacora, in or near forest.

Leptodactylus labialis (Cope).—Pacific slope near Pacora, and La Chorrera.

Leptodactylus pentadactylus (Laurenti).—Several from forest ponds near Pacora. A large edible species; one measured 356 mm. in length, outstretched. It was a dark brown at night when caught, and the following morning a very light gray.

Leptodactylus poecilochilus (Cope).—From sabanas near La Chorrera.

Pleurodema brachyops (Cope).—Three specimens were taken January 23, 1943, at the target range near the LaJoya I airfield. They were caught while laborers were shoveling gravel taken from the nearby Pacora River, although it is not likely that they came in the gravel undamaged. They most probably came with a load of sod from nearby Paso Blanco. While alive they were strikingly marked. The little disc in front of each leg was a bright blue with whitish spots. Under the discs, on part of the dorsal surface of the legs and under the armpits, was bright orange. The general color was grayish above and light beneath, with mottled throat. The skin had the moist texture of *Hyla versicolor*.

Dendrobates auratus (Girard).—Two specimens from Rio Chico, Darien.

Hyla leucophyllata (Bereis).—Three specimens from a forest pond near Pacora, while calling night of October 1, 1942.

Hyla microcephala Cope.—From forest pond near Pacora. Their call (on October 5, 1942) is an insect-like clicking.

Hyla rosenbergi Boulenger.—One of these giant hylids was taken from a forest pond near the Tatare River not far from Pacora. It was calling on October 1, 1942, my field notes describing the call only as "loud and peculiar." Another specimen was taken about 3 miles west of this location, three weeks later.

Sauria

Gonatodes fuscus (Hallowell).—At Ft. Davis, on November 29, 1943, I noticed a cluster of small white eggs in a crevice in the bark of a guácimo tree, *Luehea seemannii,* about 5 feet from the ground. There were six eggs in all, two of which had been hatched. The others were between 6 mm. and 7 mm. in diameter, spherical, with hard, brittle shells. The first egg I broke contained an almost fully developed lizard, but it was inert. I broke a second, and was somewhat startled to see the lizard jump out and run away. A third behaved in the same manner, but I captured it for identification. This specimen measured 32 mm. total length, of which 13 mm. was tail. This species is common in the Canal Zone, and often seen on tree trunks. On the above mentioned tree, and a few neighboring guácimos and a *Ceiba pentandra,* I observed a few adults and about fifteen young. Evidently a number of clutches had hatched in that vicinity within the last few days, as I had not noticed any young prior to these. Also from La Chorrera.

Sphaerodactylus lineolatus Lichtenstein.—A specimen from the basement of a house at Ft. Gulick. Panamanians had no fear of this or the preceding species, but the Salvadorean laborers were very much afraid of these gekkonids, and also of *Anolis pentaprion,* which looks somewhat similar. The common Salvadorean term for them is "cantíl" although some called them "escorpión," "salamanqueja," and a small one "cantilito." They fear even a young one, claiming that it can inflict a poisonous wound with its tail. The fact that specimens would under no circumstances harm me did not detract from this belief. The Salvadoreans, however, were not afraid of any other lizards.

Thecadactylus rapicaudus (Houttuyn).—I caught only one of this beautiful species. It was clinging to the wall of a barracks near Pacora. It bit me rather savagely, but made no scratches.

Anolis pentaprion (Cope).—One specimen from Margarita, Canal Zone. A Costa Rican laborer called it "león," and believed with the Salvadoreans that it was poisonous.

Anolis tropidogaster Hallowell.—Two specimens were taken from forests between Panama City and Pacora. One of them jumped from a bush to my neck, and from thence to my hat.

Norops auratus (Daudin).—Common in grassy areas, both slopes. I took specimens from Albrook Field, La Chorrera and Ft. Gulick.

Basiliscus basiliscus (Linnaeus).—This species occupies the habitat niche in the tropics that the species of *Natrix* do in the corresponding places in the eastern United States. They are very common along streams of all sizes. Their ability to run on the surface of the water is well known. If when one

jumps from a branch to the water and becomes wet by sinking in too deep on the impact, it must swim to safety rather than run.

Ctenosaura similis (Gray).—From the edge of a stream not far from the Pacific entrance to the Canal, one specimen.

Iguana iguana iguana (Linnaeus).—I made a rather extensive study of iguanas, and am preparing a separate account of them. The largest of many hundreds I observed was a male from Ft. Gulick which weighed 13¼ pounds and had a total length of 1689 mm. (66½ inches); 101 mm. (4 inches) of the tail had been regenerated, presumably to almost normal length. I have talked to a few people who have lived for several years in the Zone without having seen a wild iguana. I once counted 55 iguanas sunning themselves on the treetops along 3 miles of road between Margarita and Ft. Davis. I was riding in a truck at about 25 miles per hour. Panamanians call the female "iguana," but the male is always "gorrobo."

Ameiva ameiva praesignis (Baird and Girard).—The "vorrigero" is very common. By sitting still I've had specimens of this large lizard come quite close to me and eat bread and cake crumbs from my lunch. One also ate small earthworms. Taken on both slopes.

Gymnophthalmus speciosus (Hallowell).—One from a meadow near Pacora.

Leposoma dispar Peters.—One from the edge of the jungle at Ft. Davis.

Mabuya mabouya mabouya (Lacépède).—The Panamanians welcome this lizard in their homes, recognizing its insect-eating propensities. They call it "limpia casa." Salvadoreans call it "comadreja."

Serpentes

Leptotyphlops goudotii (Duméril and Bibron).—One specimen was taken while cutting sod from a grazed sabana at a place called Paso Blanco, on the highway between Pacora and Chepo. This is the first specimen to be taken from Panama, the species heretofore having been known only from the Magdalena Valley of Colombia.

Constrictor constrictor imperator (Daudin).—Rather common.

Epicrates cenchria maurus Gray.—Both slopes. Observed at Diablo, Pacora, Old Panama and Mt. Hope.

Ninia maculata (Peters).—One specimen from the Mt. Hope Cemetery.

Erythrolamprus bizona Jan.—One I caught at Pacora, after a week in captivity, ate a young boa, *Constrictor c. imperator*. Another from Paso Blanco.

Leimadophis epinephalus epinephalus (Cope).—I saw only one of this species, which I captured at Ft. Gulick. When disturbed it flattened out in the manner of *Heterodon*, displaying its beautiful pastel coloration to good advantage.

Xenodon rabdocephalus (Wied).—Specimens from Ft. Davis, Ft. Gulick and the Navy tank farm, West Bank (Pacific slope). The Salvadoreans call this species (and probably a few others) "víbora castellana" and believe it to be very dangerous. Some of the Panamanians, perhaps incorrectly, call it "bocaracá." A specimen I caught at Ft. Davis attempted to bite. While holding it, I noticed blood on my fingers, and some coming from the snake's mouth, but it had not bitten me, nor had I hurt it in any way. Only once

before have I noticed this voluntary bleeding at the mouth, and that was with a *Heterdon contortrix* in Indiana. Neither snake had been harmed in the slightest, other than being frightened. The paired fangs in the upper jaw of *Xenodon,* like those of *Heterodon,* add to its sinister appearance.

Pseudoboa neuwiedii (Duméril and Bibron).—One of these dainty little snakes was taken from a sabana near Pacora. It was 295 mm. in length, and contained an immature *Ameiva* 150 mm. in length, which was a bulky meal for it.

Phimophis guianensis (Troschel).—Occasionally beautiful snakes like this and the preceding do much to compensate for the lack of quantity in tropical collecting, to one who has collected from some of the highly productive areas of the United States. One specimen from the highway 5 miles west of Chepo. Sabana country.

Drymobius margaritiferus margaritiferus (Schlegel).—Fairly common in the vicinity of Pacora. Salvadoreans thought this species, which they called "borigira," and "tamagás," capable of killing either by fangs or the spiny tip of the tail. One should pay little attention to native names unless a large number of natives from different areas agree on a certain term. A country Panamanian or Salvadorean is no more accurate than a Pennsylvania farmer in naming snakes, but either are far better than city dwellers of their respective countries.

Dryadophis melanolomus alternatus (Bocourt).—Near the golf course at Ft. Davis I saw three of these snakes within as many hours, within a radius of 200 yards. One of them had a live mouse in its mouth, which it did not release until after I held the snake in my hand. Another was caught near the Pacora bridge.

Dryadophis pleei (Duméril and Bibron).—A common species in swampy meadows near Pacora. One 1029 mm. specimen contained an adult *Ameiva,* with all but the hind legs and tail digested. From the vent to the tip of the tail, the lizard measured 203 mm. I was given "barriquira" as a native name.

Leptophis occidentalis occidentalis (Günther).—One specimen from near Pacora.

Oxybelis aeneus (Wagler).—One from near Pacora. I was given "cotina" as a native name, but by most it is called "bejuquilla" as are most of the vine snakes.

Oxybelis fulgidus (Daudin).—A specimen was caught at Diablo Heights with a small lizard projecting from its mouth.

Imantodes gemmistratus Cope.—One from near Paso Blanco. All of the "vine" snakes that I collected were taken from tall grass; none from bushes or trees.

Drymarchon corais melanurus (Duméril and Bibron).—A 2165 mm. specimen from a drainage ditch at France Field. The Panamanians call this species "culebra de agua," and claim that it is fond of eating the basiliscs so common along streams. Some of the Salvadoreans call it "tumbadora," and believe the old whip-snake story concerning it.

Spilotes pullatus pullatus (Linnaeus).—Near Pacora bridge; La Chorrera; Mt. Hope tank farm. The Panamanians aptly call this large species

"monteadora" or "iguanera," the Salvadoreans, "chichicua." The sabanas in the vicinity of La Chorrera have little "islands" of trees and brush. In one of these thickets we discovered one of these handsome snakes stretched out on the uppermost branches of a "cardenillo" tree. This tree, and others surrounding it, were from 20 to 25 feet in height. My crew of laborers helped me capture it, not without some difficulty, as it insisted on gliding around on the tree tops. My helpers were not anxious to get near it, as it is one of the "whip" snakes to them. After climbing several trees and shaking them, we managed to get it on the ground, where it was cornered until I descended and captured it. It measured 2427 mm. (tail 578 mm.). Like others of its kind in Panama, it was host to a number of ticks.

Leptodeira rhombifera Günther.—Rather common. Several specimens from near Pacora, and one from Ft. Davis. Rather generally called a "víbora" by the natives.

Enulius flavitorques (Cope).—Specimens taken from near Pacora, Diablo Heights and Margarita.

Micrurus nigrocinctus nigrocinctus (Girard).—A specimen taken at Ft. Gulick had eaten a young *Mabuya*. A specimen only 335 mm. in length which I caught at Ft. Davis impressed me with its aggressive behavior, as I had heard so much about coral snakes being of mild disposition. It was alongside a drainage ditch, which, although it had been cut, had quite a bit of vegetation on the ground. In trying to pin down the snake with a leaf stem, it seized the stem and hung on tenaciously. Such small snakes are difficult to pick up. On Barro Colorado Island, between Kilometers 1 and 2 on Wheeler Trail, I caught a large specimen. I held it down with my shoe to prevent its escape in the thick vegetation bordering the trail. It struck my shoe repeatedly.

Micrurus dunni Barbour.—Two of these interesting little coral snakes were taken not far from the ruins of Las Mitas near La Chorrera.

Bothrops lansbergii (Schlegel).—Four of these common pit vipers were taken from the Pacora region. Dr. Dunn states that of 7308 records he has from the Zone area (November, 1944) 771 of them were of this species. Fortunately they are of small size.

Bothrops atrox asper (Garman).—Between Kilometers 11 and 12 on the D. Fairchild Trail on Barro Colorado Island, on March 1, 1944, I stepped over a nice "equis" as it is known to the Panamanians. I had the three year old daughter of a friend astride my neck. An army nurse who was right behind me, called my attention to the snake lying in the path. I gave the child to her, and after taking a couple of photographs, caught the snake, from which I milked out a very large quantity of venom. Apparently the snake had not fed recently. From past experience I believe it much safer to carry venomous snakes with as little venom in them as possible. We carried it back to the laboratory in my undershirt, where Dr. Zetek kept it for some time. On April 15 it gave birth to 20 or more young.

Lachesis muta stenophrys Cope.—One specimen was taken from a farm near Arraijan on September 20, 1942.

Crocodilia

Caiman fuscus (Cope).—Most of the natives of Panama, in the vicinity

of the Canal Zone at least, call this small crocodilian "cocodrilo," and the large crocodile they call "caimán"; just the reverse of the English designations. Less commonly the smaller species is called "lagarto negro," and the larger "lagarto blanco." The Americans in the Zone usually call the cayman "alligator." I have observed this species in the largest rivers, and tiny streams that were dried up between pools in the dry season. They often live by one pool for a long time, although it is apparent that some of them wander about, possibly returning to a home pool. One specimen I noticed on many occasions for months, floated in the pool below the spillway at Miraflores dam. Another specimen I observed one morning on the bank by a deep pool in the Rio Jujucal, between Pacora and Chepo. That afternoon I came back to the same place and saw it again, this time hitting it with a load of 7½ shot from a 12 gauge gun, which did not seem to injure it. Four days later I came back to find it in the very same spot. This time buckshot at a distance of about 75 feet enabled me to add it to my collection.

I have seen caymans in muddy ponds and swamps, as well as in clear streams. I saw one in the Rio Pacora whose head was quite ruddy in color. It is almost useless to shoot them in deep or muddy water, as they sink on being shot. I have heard that they will rise in a day or two, but it seems to me that the skin would then be worthless. The leather from the cayman is far superior to that of the crocodile for making leather goods. Their numbers are doubtless far less now than a few decades ago in Panama. Many skins are now imported to Panama for use in manufacturing leather goods, which at present command a very high price.

Crocodylus acutus Cuvier.—With buckshot from a 12 guage gun at 70 feet I killed a specimen that measured 3253 mm. in length (10 ft., 8 in.) making it by far the largest herpetological specimen that I had taken in 25 years of collecting. It had a girth of 1143 mm. but its stomach was empty, except for about a quart of gravel, and a flattened and much chewed tin can, gallon size. The Rio Cabra, from which I took the specimen, although small, contained other crocodiles, but they were very difficult to approach. At slightest crack of a twig, or movement of leaves, they rushed into the water and disappeared. I suspect that in clear rivers, both the crocodile and the cayman will keep the pool they occupy roily so that they can not be seen under water. In otherwise clear streams, some pools never seem to become clear, and I could never find a crocodile in a clear pool unless it was in a larger stream where the current kept the water clear.

In spite of their timidity, crocodiles will sometimes attack human beings, if the latter are small enough in proportion to their own size. "La Estrella de Panama" for October 8, 1942, gives an account of a crocodilian attacking and killing a ten year old child.

Chelonia

Kinosternon cruentatum Duméril.—Two specimens were taken when crossing a road, apparently just having left the Rio Cabra (near Pacora). These were the only turtles collected, although others were observed, including marine turtles and a species common in the Rio Cabra, possibly *Pseudemys*.

R. F. D. 2, Polk, Pennsylvania.

Nesting Habits of the Mud Turtle

By Neil D. Richmond

THERE is no record of late summer nesting of the mud turtle *Kinosternon subrubrum subrubrum* (Lacépède). There are few published records of late nesting of any of the turtles and none of these suggest that there might be a period of late summer nesting normal for the species observed. Observations from 1940 to 1944 at Shackelford Farms, near Lanexa, in New Kent County, Virginia, disclose that in this locality *Kinosternon* normally has a late summer nesting period in addition to the nesting period in early spring.

Kinosternon is abundant here as are the associated forms, *Sternotherus o. odoratus, Chelydra s. serpentina, Pseudemys r. rubriventris,* and *Chrysemys p. picta.* Of these, *Kinosternon, Chrysemys,* and *Pseudemys* have similar preferences in nesting sites. The same plot of ground serves as a common nesting area for these three turtles and also for one snake (*Abastor*). The largest number of nests were found in sand roads and in the edges of sandy fields in the vicinity of marshes and on the points of high ground which extend out into the marshes. Since the soil of the lower coastal plain terrace in this locality (Pamlico) is sandy, most of the nests seen were in sandy soil. That soil texture is not a limiting factor is indicated by the presence of nests in the clay banks of an artificial pond. Good drainage and exposure to the sun are of more importance as favorable factors, and appear to be the primary requisites for nest sites. While nests have been observed in thickets and in open woods, they have not been found in situations as shaded as that in which both *Chelydra* and *Sternotherus* have been observed laying. Most of my observations were made in one nesting area, a zone approximately 25 feet wide and 1700 feet long, around two sides of a sandy field, adjacent to a large marsh. This nesting area was under observation from 1940 to 1944. It was observed regularly every two days in September, 1942, when late summer nesting was first noticed. During the summer of 1944 it was examined after every rain, when new nests were distinguishable by the freshly disturbed soil.

The number of newly constructed nests and the dates when they were found are shown in Table I. Most of these nests had been opened by predators, but occasionally an undisturbed nest was recognized by the appearance of the soil; additional nests were exposed by plowing.

Nesting starts the last week in March and was observed in April and June. Observations are lacking for May. In 1944 there was an unusually long period of hot, dry weather with no rain from April 23 until June 30. On June 30 there was a steady rain lasting all afternoon and continuing until about midnight. The following day (July 1) thirty-four nests were found that had been opened during the night by skunks. The appearance of the shells indicated that these eggs had been laid the night before or the previous day. In addition to these, two undisturbed nests were found, both of which had been made after the rain. During July, 1944, there were frequent showers but new nests were seen only once, on July 14, when nine were discovered. All had been opened by skunks except one that had just been completed and

was still undisturbed. No more nests were observed until August 20. However, on August 7 two *Kinosternon* were seen leaving the nesting area. Although a careful examination of the immediate vicinity failed to disclose any nests, I assume that they had laid since their backs were covered with moist sandy soil.

In 1942 the nesting area was frequently visited until November, but the latest date on which new nests have been seen during this study is September 23, 1942. Two nests were found at that time. This followed a ten day period during which no nests were observed, although the area was examined every two days.

TABLE I

NESTING DATES OF *Kinosternon*

Date	Number of nests	Remarks
April 1, 1942	3	Unearthed by plow
April 12, 1944	12 plus	Opened by predators
April 18, 1940	2	Unearthed by plow
July 1, 1944	36	34 opened by predators
July 14, 1944	9	7 opened by predators
August 7, 1944	0	2 adults leaving field
August 20, 1944	1	Opened by predator
August 23, 1944	5	4 opened by predators
August 29, 1944	16	15 opened by predators
September 6, 1942	5 plus	Opened by predators
September 7, 1942	2	Turtle observed laying
September 13, 1942	14	11 opened by predators
September 23, 1942	2	Laid since Sept. 21

Table II shows the number of eggs found in undisturbed nests. In those nests opened by predators the egg shells were so broken and scattered that I made no attempt to count them. As shown in the accompanying table, the number of eggs varied from two to five, three and five occuring most frequently.

TABLE II

NUMBER OF EGGS IN NESTS OF *Kinosternon*

Number of eggs	Number of nests	% of total
2	2	14.2
3	8	57.1
4	1	7.1
5	3	21.4

Kinosternon have been observed moving to and from the nesting area at all hours of the day; that they nest at night is indicated by the number of newly made nests found in the morning. No one *Kinosternon* was observed continuously through the process of nest construction and laying. However, four females in various stages of nesting were seen during the course of this study. They are apparently more easily disturbed than most turtles as all of them remained inactive while under observation.

From these observations and from the study of the completed nests, it is possible to describe the nesting process. The female may try several places before she finds a suitable site. Then she starts digging with her fore feet, thrusting the dirt out laterally until she is almost concealed. At this point, she turns around and completes the nest with her hind feet. During this stage, and while laying, only the head of the turtle is visible. After the eggs are deposited, the turtle crawls out of the ground and may proceed directly

to the water, or she may make a slight effort to conceal the nest cavity by levelling the site and scratching around it. Of the fourteen completed nests examined, only three showed any indication that the turtles had tried to conceal them, and they were conspicuous as disturbed areas, not at all like the carefully concealed nests of *Pseudemys* observed in the same field.

The completed nest is usually a semicircular cavity from 3 to 5 inches deep, entering the ground at a 30° angle. This cavity extends above and slightly beyond the position of the eggs. The soil around and immediately above the eggs is firmly packed, indicating that the turtle carefully covers the eggs even though no effort is made to conceal the nest. In the loose sandy soil where these nests were observed the nest cavity is soon obliterated by rains.

Of the many animals that probably feed on the eggs of *Kinosternon*, skunks are the only ones that have actually been observed to do so, and theirs are the only tracks seen around the opened nests. In this locality, skunks are a significant factor in the control, not only of *Kinosternon*, but of all egg laying reptiles. The adult turtles are apparently not attacked in their movements to and from the nesting area. In the four years that this area was observed, only five dead specimens were found. Two had become entangled in a wire fence, and the other three had been accidentally killed in a road.

The only hatchlings of *Kinosternon* observed in this area were those unearthed by plowing during April. Therefore, some of them spend the winter in the nest. Whether or not any leave the nest in late summer has not as yet been determined.

These observations disclose that *Kinosternon* in New Kent County, Virginia, has a much longer nesting season than that reported for any of the other turtles in eastern North America. As shown in Table III,

TABLE III

EARLIEST AND LATEST DATES NESTING OF TURTLES HAS BEEN OBSERVED IN NEW KENT COUNTY, VIRGINIA

Name	Earliest date	Latest Date
Kinosternon	March 31	September 22
Pseudemys	May 18	July 4
Chelydra	May 22	June
Chrysemys	May 16	July 1

Kinosternon start laying one to two months earlier than any of the other local turtles whose laying has been observed. Nor did I see any indication of late summer nesting in any of the other species. This extended nesting season probably accounts, in part, for the reputation of *Kinosternon* for being more or less terrestrial; it would be of interest if the sex of all the specimens found on land during the summer months could be determined.

SHACKELFORD FARMS, LANEXA, VIRGINIA.

Some of the Activities of the Sidewinder

By Raymond B. Cowles

CASUAL observers have frequently made verbatim reports of instances in which they have found sidewinders that have buried themselves just below the surface of the ground. The reports describe cases in which only the head remains in sight, and less frequently they describe the accidental discovery of completely submerged individuals. In both of these types of inferential self-concealment, the observers have insisted that the snakes had buried themselves, that is, that they had neither been "holed up" just below the surface, nor been covered by accumulations of wind drifted sand. The north African vipers, *Cerastes cornuta* and *C. vipera,* the old world, desert counterparts of the south-western sidewinder or horned rattlesnake, are reported to bury themselves completely, thus by analogy and in view of the horned rattlesnake's similarity in locomotion, habits and habitat, it would be expected to behave in a similar manner.

Curiously enough, there seems to be no detailed description of the bedding-down habits of the sidewinder, and over a period of some fifteen to twenty years of tracking and collecting these snakes, I have remained skeptical concerning these reports of self-burial. While I am now somewhat less dubious about this habit in the sidewinder, I believe that wind drifted sand is far more frequently the cause of sand immersion than are the snake's own efforts.

When bedding-down, sidewinders form a tight coil or pad and then proceed to edge or nudge the sand outward from beneath their bodies and thus form a saucer-shaped depression (Cowles and Bogert: Pl. 26, fig. 2) in which they lie with the back of their body flush with the surrounding surface. In this position, any appreciable drift of sand would tend to submerge the snakes by either surface movement of rolling particles of soil or by the deposition of lighter wind-borne material. The absence of tracks leading to snakes buried in this manner, would indicate the manner of submergence, and it would also account for the general failure to find them in these positions.

This passive submergence of bedded-down snakes is probably more frequent than the reports would seem to indicate, especially since these animals usually appear to select locations in close proximity to bushes where the interruption of wind might precipitate the air-borne particles at a more rapid rate than elsewhere.

In the daytime, sidewinders usually come to rest in the shade of bushes or low shrubby growths, although they are not infrequently found in the open, even during the summer. The factors militating against their presence in the open during the summer daylight hours have been discussed by Mosauer (1933, 1936), however, the fact of this extraordinary occurrence has been reported and figured (Cowles and Bogert: Plate 26, Fig. 1).

In the vast majority of cases, bedding down seems to consist solely of the aforementioned edging process, but when this is carried out until the body lies below the level of the piled sand, there may be some inward falling soil that partially conceals the outer portion of the flattened pad. A little

PLATE I

Crotalus cerastes laterorepens bedded down and showing self-burial by the piled up sand and imprints of the gular scutes.

encouragement of this process would result in burial of most of the body and in many instances might provide such adequate concealment as to prevent detection, a fact that may explain the many trails that are followed in vain.

One of the relatively easy methods of collecting these snakes is by tracking them over the sandy or dusty ground in which they live. Not only is the method a fruitful one, but it also yields much information on the animal's habits. Nevertheless, in none of the several dozen instances in which the snakes have been tracked to their resting places, has there been any deviation from the tactics described above, and it had seemed increasingly improbable that self-burial occurred. However, this spring, on April 29, 1945, a single individual of the sidewinder, *Crotalus cerastes laterorepens,* apparently in the process of self-submersion, was found near La Quinta, Coachella Valley, California.

The extent to which coverage had been achieved is shown in Plate I and the imprints left by the gular scutes as the head smoothed sand over the body are clearly visible. The tracks show that the last few inches of ground were traversed by the slow caterpillar type of locomotion although up to this point the tracks showed that the animal was progressing by the typical sidewinding movements. The change from the diagonal, easily observed marks, to the single longitudinal crawling imprint might easily mislead a tracker conditioned by long search for the other type of imprints and it seems probable that this factor might also help to explain the scarcity of records on this habit. Certainly only a small amount of additional covering would have rendered the snake all but invisible.

The frequency with which sidewinders are encountered resting exposed to the full glare of the sun in spring and early summer, leads one to question the assumption that their crepuscular and nocturnal habits render them as photonegative as other nocturnal desert snakes. Instances of finding apparently undisturbed individuals moving about in the daytime are rare but the infrequency of these encounters may be partly due to the fact that the snake is apt to see an approaching man long before it is seen and thus it will have ample time to seek shelter or coil into an apparently resting position. Under these conditions there would be no way of determining when the snake had ceased travel and it would be assumed that it had come to rest during the night. It is also notable that during spring at least (Cowles and Bogert), these snakes maintain thermoregulation by lying at the mouths of burrows, and while doing so, frequently expose their heads to the full glare of the sunshine.

There is no question but that these animals are primarily crepuscular and nocturnal, which renders their capacity to function under conditions of extreme light variations a remarkable feature of their existence. The absence of eyelids must demand extraordinary effectiveness in the mechanism for contracting the pupilary slit and would seem to require other adjusting devices as well.

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ZOOLOGY DEPARTMENT, UNIVERSITY OF CALIFORNIA, LOS ANGELES, CALIFORNIA.

Delayed Fertilization in a Captive Indigo Snake with Notes on Feeding and Shedding

By HAMPTON L. CARSON

THE length of time that spermatozoa may be stored in the genital tract of female vertebrates and still retain fertilizing capacity has been believed to be generally quite short. Certain observations, however, such as those of Barney (1922), Woodward (1933) and especially Haines (1940) have shown that in certain reptiles this capacity can be retained over many months and even years. There is still relatively little information on this subject, and it is possible that delayed fertilization may actually be a widespread phenomenon in poikilothermal vertebrates. Observations on a captive indigo snake in the writer's collection add to our knowledge of this subject. The feeding and shedding records of this snake have been included as, despite the fact that this species is widely maintained in captivity, very few data of this kind are available.

An adult female indigo snake, *Drymarchon corais couperi* (Holbrook), 5 ft. 8 in. long, was purchased by the writer from a dealer in Merchantville, New Jersey, on January 15, 1941. The specimen was in excellent condition at that time and still is at the time of writing (Sept., 1945). It has been maintained in the writer's home completely isolated from all other snakes. Unfortunately, no information is available concerning its history before it came into the writer's possession, except that it was captured in Florida in November or December of 1940 and that it had been "feeding well."

FEEDING AND SHEDDING

During the first two winters that it was in the writer's possession, this snake was kept in a cool room, in which the average temperature was approximately 60° F. Despite this fact, the "rest period" described by Stabler (1939) was not pronounced so far as feeding was concerned (although other snakes in the writer's collection showed it), and the snake could usually be induced to take food at regular intervals during the winter months. In spring and summer, the snake displayed a voracious appetite. The feeding record, summarized in the accompanying table, reveals that a very wide variety of food, extending over four vertebrate classes, was accepted. Most of the wild birds listed were highway casualties and, although dead, were readily taken by the snake directly from the writer's hand. Despite what appears to be very heavy feeding, the snake has not grown perceptibly; a recent measurement (July, 1945) coincides exactly with one made soon after the specimen was obtained.

In the four and a half years (54 months) the snake shed 18 times, an average of once every 3.0 months. This compares favorable with the figure 3.2 given by Stabler for this species. Although no particular rest period was noted with respect to the feeding of this snake, a distinct rest period is evident in shedding. Over the entire time of captivity, only three of the 18 sheddings occurred during the winter months (i.e. in the periods between October 1st and April 1st for three and a half successive winters).

TABLE I

FEEDING RECORD OF A CAPTIVE INDIGO SNAKE

JANUARY 15, 1941—JULY 15, 1945

Kind of Food	Number eaten
AMPHIBIA (4 species, 37 specimens)	
Leopard frog	17
Green frog	18
Pickerel frog	1
Bullfrog	1
REPTILIA (4 species, 6 specimens)	
Black racer	2
Common water snake	2
Common garter snake	1
Lined snake	1
AVES (14 species, 103 specimens)	
English sparrow	76
Domestic chicken (baby chicks)	8
Starling	5
Robin	2
Domestic pigeon (squabs)	2
Slate-colored junco	2
Brown thrasher	1
Wood thrush	1
Goldfinch	1
Song Sparrow	1
House wren	1
Chimney swift	1
Ovenbird	1
Blue jay	8
MAMMALIA (8 species, 95 specimens)	
White rat (mostly adults)	39
House mouse	21
Peromyscus sp.	18
Norway rat	6
Golden hamster	3
Short-tailed shrew	2
White mouse	2
Rabbit (newborn)	2
Domestic cat (newborn)	1
Gray squirrel	1

EGG LAYING

On May 29, 1945, 4 years and 4 months after it came into the writer's possession, this snake laid five eggs. The largest of these measured 100 mm. long by 32 mm. at the greatest diameter, and the smallest 75 mm. by 27 mm. The eggs were to all appearances normal, with turgid, leathery shells studded with elevations of calcification. The entire clutch weighed 27 grams and the snake, after laying, weighed 1219 grams. After several days in the refrigerator, the eggs were opened by cutting circular holes at one end and the yolk of each was expelled individually into a finger bowl and a search for embryos was made. Examination of the first two was rather half-hearted, as the writer was guilty of a preconception that he would find nothing. Examination of the third, however, revealed the presence of an embryo, 6 mm. in length. Although moribund (probably because of 48 hours exposure to the low temperature of the refrigerator), the embryo seemed in every way normal; blood was present in the heart and aortic arches and the head process and allantois were well developed. The final two eggs definitely contained no embryos and the writer is inclined to believe the first two, which were not systematically examined, were also infertile.

Discussion

Long-delayed fertilization in vertebrates seems to be extremely rare. Among mammals, bats appear to be exceptional; thus in certain species in which fall mating is general, the sperm in the female genital tract is apparently able to retain fertilizing capacity over the winter months. Hartmann (1939), however, has rightly injected a word of caution and has pointed out that in most of the published cases, the possibility still exists that the functional spermatozoa were derived from a second mating in the spring.

The most striking reports of sperm storage by female vertebrates over long periods of time are those of Barney (1922) for the diamond-back terrapin, *Malaclemys centrata*, and of Haines (1940, for the rear-fanged snake *Leptodeira annulata polysticta*. Barney isolated ten female turtles and recorded the number of fertile eggs laid in ensuing years; he found that four out of 108 eggs laid during the fourth year were fertile. Haines, who isolated a single specimen of *Leptodeira* in March, 1934, reports that some of the eggs laid by this snake in 1940, six years later, contained embryos. As in both of these cases clutches of eggs were laid in succeeding years, sperm were obviously stored in an inactive condition and the phenomenon is clearly not one of long-delayed gestation period. This is further borne out by the experiments of Rahn (1940) on the garter snake (*Thamnophis s. sirtalis*), whereby it was proved that delayed fertilization in this form may occur at least one month after mating. A similar but less striking delay in fertilization has been recorded by Woodward (1933) in the African night-adder (*Causus rhombeatus*). A female of this species retained functional spermatozoa for five months.

Aside from the possibility of parthenogenesis, which seems very remote, the present case in *Drymarchon* is clearly due to delayed fertilization, involving storage of spermatozoa in the genital tract of the female for a period of at least 4 years and 4 months. The behavior, shedding, feeding and light conditions under which the snake was maintained during the spring of 1945 differ in no way from those of the four previous springs and there is no obvious explanation for the failure of the snake to lay eggs during the first four years of captivity.

Investigation of delayed fertilization must be based on long-extended observations of isolated captive animals. Few reptiles find the conditions imposed by captivity conducive to the production of eggs in succeeding years. Thus the *Drymarchon* record, together with the observations of Haines, Barney, and Woodward, suggest that long-term storage of spermatozoa may be a more widespread phenomenon than is generally thought, and should serve to focus the attention of herpetologists on the problem.

The retention of functional spermatozoa over a long period by the female should be of distinct advantage to snakes, and possibly to other cold-blooded vertebrates with non-gregarious habits. It may be significant that the three snakes involved (*Drymarchon, Leptodeira* and *Causus*) are warm-climate species that lack the gregarious habits of hibernation characteristic of certain northern snakes. Such species should benefit from the capacity for sperm storage, as the chance of finding a yearly mate is presumably inversely proportional to the degree of gregariousness manifested by the species.

SUMMARY

The feeding and shedding records of a captive indigo snake (*Drymarchon corais couperi*) are given for a four and a half year period. The snake fed heavily on amphibians, reptiles, birds and mammals.

After four years and four months in solitary confinement, the snake laid five eggs, at least one of which was fertile. This is interpreted as an extreme case of delayed fertilization. Delayed fertilization in vertebrates is discussed and the suggestion is made that the phenomenon of sperm storage by the female over long periods of time may exist widely in snakes, especially those not having gregarious habits of hibernation.

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DEPARTMENT OF ZOOLOGY, WASHINGTON UNIVERSITY, ST. LOUIS, MISSOURI.

Notes on the Social Behavior of the Collared Lizard[1]

BY BERNARD GREENBERG

THE iguanid lizard *Crotaphytus collaris collaris* Say is one of the more conspicuous of the lizards that inhabit the western semi-arid regions of North America. It was first reported by Say in 1823. Nothing concerning its social behavor is to be found in the literature. Cope (1900: 251) remarked that "it is perhaps the most pugnacious of our lizards, opening its mouth when cornered, and biting savagely." This is not a criterion of aggressiveness but the first phrase of the quotation may prove to be true. Collectors have often noted that these lizards are swift and frequently run on their hind legs, with the front ones raised off the ground. Probably because of this capacity for rapid locomotion and the extensive individual

1 The author is much indebted to Dr. W. C. Allee for generous aid and criticism, to Karl P. Schmidt and Clifford H. Pope for a critical reading of the manuscript, to Drs. Clay G. Huff and George Thompson for the loan of the lizards and to Dr. LaMont Cole for aid in photography.

range thus made possible, field records have seldom included more than a place notation.

Animals Studied and Their Treatment

On March 10, 1943, 6 male and 6 female collared lizards were obtained as a loan from the Department of Bacteriology and Parasitology of the University of Chicago, where they had been kept for almost 9 months; they had not been used for experimentation. The males ranged in length of head and body from 8.8 to 9.9 cm. and 4 of the females measured 8.3 to 9.4 cm.; tail lengths were 16.2 to 18.2 cm. Two of the females died before the end of the experiment; they were estimated as intermediate in size.

The bottom of a large aquarium (4′ x 2′ x 1.5′) was insulated with paper and then covered with white sand to a depth of several inches. Some large coral rocks were grouped at one end for shelter; three desk lamps fitted with 15, 20 and 40 watt bulbs, and with the bases removed, were placed flat on the sand so that the reflectors furnished sources of heat radiation. The stronger bulbs were covered to prevent burns, one with screening, the other with a flat tin dish (Fig. 1). The lizards at first remained behind the rocks and attempted to dig underneath them. After a few days, all were staying near or on the heating devices.

Additional lighting was provided by two lamps with 100-watt daylight bulbs. The diet consisted entirely of mealworms, which were eaten readily; water was provided in finger bowls.

Early in the study, it was observed that a single active male was dominant over all the other males, and that these tended to hide in the corners. The 5 subordinate males and 3 of the 6 females were removed to an adjacent terrarium (8′ x 2′ x 1.5′), which was likewise arranged with sand, heat radiators and artificial lighting. This was later subdivided, so that there were as many as 4 separate groups, each composed of a dominant, sexually active male and one or more females.

The period of observation extended from March 10 to May 21, 1943. During this time, 120 records were made on 18 observation days. Table 1 lists these according to types of behavior. In the following outlines of the patterns, all the records have been used to form composite descriptions.

Dominance—Subordination

The Fighting Pattern.—The 17 recorded instances of the fighting pattern (Table 1) are not a measure of the aggressiveness of *Crotaphytus* males since the most dominant individual had to be segregated from the other males because the latter were so thoroughly subordinate in his presence. It is probable that in the field environment, the males are organized along territorial lines.

The fighting male assumes a posture that appears to be characteristic for iguanid lizards (Figs. 2, 3, 4 and 6). The throat is puffed so that the yellow-orange coloration shows clearly, and the body is laterally compressed. Stiff and deliberate bobbing movements are performed, the male rising higher and higher in jerky fashion. Since the hind legs are larger than the front legs, the male may rise till only the tips of the fingers still touch the substrate (Fig. 3), and he then flings himself at the opponent with great speed, often darting around him to attack from the other side. The attack may be so

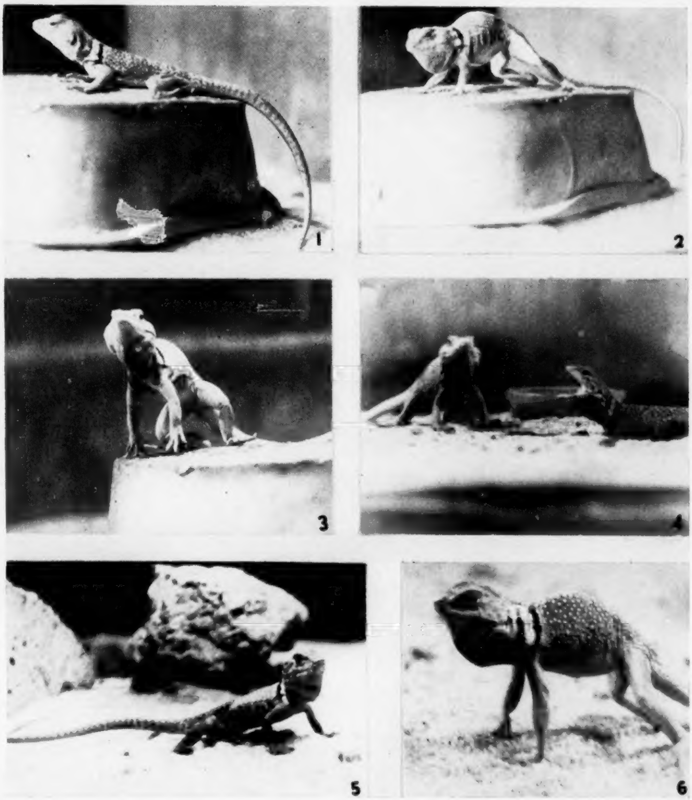

PLATE I

Fig. 1. A male *Crotaphytus* in resting position on a heat radiator (tin dish covering a lamp reflector).

Fig. 2. The same male in fighting posture, upon introduction of a rival.

Fig. 3. The male bobs stiffly, rising higher and higher until only the tips of the fingers touch the dish.

Fig. 4. A subordinate male opening mouth wide in defense as the dominant male attacks.

Fig. 5. A female, showing the avoidance posture; the body is dorso-ventrally compressed and the throat is puffed. Next she would elevate the pelvis and stalk off in stiff-legged fashion.

Fig. 6. Another fighting pose of the same male, just before he dashes at his opponent.

sudden that the other male, failing to escape, gets bitten punishingly across the head. Few of the opponents of the dominant male fought back, and the encounters were accordingly not prolonged.

The strength of these attacks was demonstrated in dramatic fashion by an incident observed on April 4. The dominant male dashed at and bit another male, who broke away and assumed a defensive attitude (to be described below). Just at this moment, one of the females approached and got between the two; she also showed the defensive posture. The male apparently mistook her for his opponent, for he seized her head in his jaws; she was entirely helpless, and when finally released was unable to move for some time. The female died several days later, probably from the effects of the bite.

TABLE 1

FREQUENCY OF RECORDED INSTANCES OF THE BEHAVIOR PATTERNS

Pattern	*No. of times shown by male*	*No. of times shown by female*
Fight	17	0
Subordination	6	21
Courtship	57	2*
Mating	6	6
Mixture of Fight and Courtship	5	0

* Vibratory courtship bob, followed by approach toward male; in one case this was in response to the male's courtship.

The intensity of the display of aggressive behavior appeared to be influenced by light, temperature, or both. On April 27, the usual 100-watt lamps were replaced by four 400-watt lamps for photographic purposes. The effect on the dominant male was immediate; he fought a series of introduced males with much greater vigor than ever before displayed. He rose up higher in fighting posture and when attacking, circled completely around the intruders, going up on hind-legs only, while maintaining the fighting posture. The invaders of his territory were quickly defeated.

Subordination Response.—Both males and females, when courted or attacked by a dominant male, show an interesting avoidance behavior. They puff out the throat but flatten dorso-ventrally rather than laterally, elevate the tail-base and arch the tail, then stalk away in stiff-legged fashion; if the dominant male comes too close, they open the mouth wide in defense. Figures 4 and 5 illustrate two phases of this reaction but not the whole peculiar posture. Unreceptive females, when thus avoiding active courtship, also hop in a manner that resembles the behavior of female *Sceloporus* in a similar situation (Noble and Bradley, 1933).

The females gave this response much more frequently than the males (Table 1). They were never observed to fight among themselves, even when kept from the males.

Sex Recognition

Sex can be distinguished with ease by the observer, for there are not only distinctive color patterns but also obvious differences in the shape and dimensions of the head. The male head, measured from snout to center of tympanum, ranged in length from 2.5 to 2.8 cm. while that of the female was 2.2 to 2.5 cm.; the widths, measured between the centers of the tympana were 2.4 to 2.6 cm. for the males and 2.2 to 2.3 cm. for the females. Ditmars (1933: 72) describes the pigmentation of the sexes in the breeding season as follows:

> The male is rich green, profusely dotted with pale yellow spots; on the neck is a double sooty black collar; as completing touches to the gay coloration, the throat is of a deep orange hue, while there are numerous rusty red spots scattered over the hind legs.—The female is normally a slaty grey, with a much narrower collar than the male. Before the eggs are laid however, her sides assume the brightest of brick-red hues, dots of the same color appearing on the limbs and sides of the tail.

Like other animals kept for long periods on diets deficient in carotene pigment, our specimens had subdued colors; the orange shades were replaced by yellow and the reds tended toward orange.

Usually the males, readily distinguishing sex, courted the females and fought other males. However, a subordinate male occasionally became active sexually and courted all other individuals. Sometimes a male showed fight that soon changed to courtship (Table 1). This usually occurred when the attacker had moved around to the rear of the opponent; it was also observed that when a subordinate sat so that his throat was not visible, the dominant male did not molest him. Apparently, the yellow throat-color aids in sex recognition. The most aggressive of the males, holding territory in the original terrarium, was tested for recognition of sex by the introduction alternately of a series of 5 males and 5 females. Regardless of which was presented first, the male invariably courted the females and fought the males. Recognition seemed especially clear when the male was in a position to see the yellow throat; its absence in the female would appear to be a factor in his toleration of her.

Sexual Behavior

The male's courtship performance differs from his tense fighting one in both posture and tempo of movement. The courting male is relaxed rather than tense; he nods his head and moves toward the female, then nods again and attempts to mate. This is an interrupted strut and the male covers ground before repeating the bob; perhaps this modification of the iguanid pattern is an adaptation to the speed of locomotion characteristic of this desert species.

The unreceptive female usually shows the defensive posture; she avoids the neck grip by getting around behind the male as he courts, the two circling each other until the male stops. Several times a male made strenuous attempts to grip and the female hopped, body flat to the ground, repeatedly reversing position. To be successful, the male must mount on her back and take hold at a particular place on the neck skin. One female when seized there turned and twisted until she was on her back, and the male had gripped her throat. Even a sick female can manage to escape; once a dominant

male seized a sick female and although he carried her about for some time, was unable to complete copulation.

On April 15, one of the females showed receptivity and mated with the dominant male of the second terrarium. The male gripped her on the neck, carried her about for a little while, and moved his tail into mating position. While he rested on her right side, he clasped her tail-base with the left hind leg and inserted the left hemipenis. The mating lasted approximately 40 seconds and was complete. It was found that this male could be stimulated to copulate with the same female by introducing a subordinate male or a different female; at first he fought with the male, but coming upon him from the rear he changed to courtship and mounted. When the receptive female was placed nearby, he immediately shifted to her and mated. The same thing took place when he courted another female unsuccessfully and was then presented with the receptive one. From April 15 to April 23, this female was mated 5 more times and was the only one observed to permit copulation. The 6 matings averaged 22 ± 5 seconds in duration.

On April 27, some 12 days after the first observed copulation, orange spots became prominent on the sides of the female and persisted for the remainder of the observation period. She laid 8 large eggs on May 14; the oviposition was not observed. Previously two other females showed these interesting orange spots for some time before egg laying. Each deposited 6 eggs.

Discussion

Within the family Iguanidae, the few species that have been studied have similar behavior patterns. Common elements in fighting are the lateral compression of the sides and puffing of the throat; all species perform stiff bobbing movements. Accessory pigmentation is displayed in a variety of ways. Some have merely heavier melanophore concentrations on the throat; others like *Sceloporus* have permanent blue coloration on throat and sides, which comes into view when the fighting posture is assumed. *Crotaphytus* resembles *Sceloporus* in having gular chromatophores, but it does not display prominent side colors. *Anolis* elaborates this theme by the development of a retractable gular fan or dewlap, which seems to be of a different color in each species (Barbour, 1926: 67).

A typical iguanid characteristic, the dorsal crest, is not seen in the collared lizard and in this respect it again resembles *Sceloporus*. *Crotaphytus* seems to rely more on speed and vigor of biting; in correlation, the head and jaws are broad and well-muscled.

The avoidance posture of the collared lizard has not been reported for any other species; closest approach is found in the description of the behavior of the anestrous female *Sceloporus* by Noble and Bradley (1933: 64):

> It consists of rising high on their four legs and hunching the back until it forms a dome. No male was ever observed to assume this attitude. Sometimes the female holds this position indefinitely, but usually she hops up and down on the ground in a stiff-legged fashion, progressing about two centimeters with each hop.

The above authors show in their Figure 8 (p. 65) that the female *Sceloporus* also puffs the throat. Usually, the collared lizard does not hop

but stalks away, and its body is very much flattened dorso-ventrally, rather than domed.

Common elements of courtship and mating in all species of this family are the relaxed position, vibratory head movements, strutting advance, mount, grip on the neck and the mating position. The special adaptation of *Crotaphytus* is the "interrupted strut," in which the male stops bobbing and dashes toward the female, only to resume the quick head movements before mounting.

For the family as a whole, behavior patterns seem to be more conservative than many structural modifications. Adaptive radiation into a series of habitats, from desert to tropical arboreal, has induced specialization in structure, especially of the skin and exoskeleton. Thus *Phrynosoma* is elaborately modified for desert life, with many spines and excrescences and dorso-ventral flattening. Nevertheless, its courtship performance is a representative one. The collared lizard, adapted to bare, rocky places, with the ability to move quickly over wide areas, shows only minor variations of the generalized courtship and fighting patterns.

Summary

The social behavior of *Crotaphytus collaris collaris* Say is typical in general of the iguanid family of lizards.

Only the males are aggressive; the fighting pattern is modified in correlation with the speed of movement and pugnacity of this species.

An "avoidance" response of subordinate males and females is described.

Males show marked ability to recognize sex; it appears that the yellow-orange throat color of the male functions as part of the signal (Lorenz-type releaser) complex.

The courtship performance of the male is representative of the family in every respect except that the strut is interrupted by swift advance toward the female, only to be resumed as the male mounts. Although all females are courted, copulation can occur only with receptive ones.

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Whitman Laboratory, University of Chicago, Chicago, Illinois.

Herpetological Notes

NOTES ON AMPHIBIANS FROM BICKLE'S KNOB, WEST VIRGINIA.—On the night of April 24, 1944, I collected amphibians along the U. S. Forest Service highway 1½ miles east of Bickle's Knob, Randolph County, West Virginia. This is along the crest of Shavers Mountain, near the headwaters of Condon Run, and has an elevation of 3750 feet. Both sides of the road are lined with second-growth red spruce (*Picea rubens*), with occasional trees of yellow birch (*Betula lutea*) mixed in. There is no standing mature spruce, although large decaying spruce logs are abundant. The present stand is in the pole stage, 30 to 40 feet in height, with an abundant crop of seedlings along the road banks and in the openings.

Heavy rain had fallen in the afternoon, and a light fog was rising during the evening. The temperature in the valley, almost 2000 feet below, was 65° F. at 7:00 P.M., and I guessed the temperature on the mountain at the time of my collecting at 55°–60° F. Collecting was carried on for a few minutes over an hour, along a 300-yard stretch of the highway, with occasional short excursions into the denser timber away from the road right-of-way. Fifty-nine specimens of five species were deposited in the Carnegie Museum, Pittsburgh, Pennsylvania:

Plethodon glutinosus glutinosus (Green).—Two individuals were found along the road. I have not often found this species in the spruce forest, although it occurs at somewhat higher elevations in deciduous woods.

Plethodon nettingi Green.—This was the most numerous salamander and 33 specimens were taken. They started emerging soon after twilight, and were active during the entire period. Most of the individuals were found crawling on moss and logs under the denser spruce stands, as might be expected since the decaying spruce logs (in which many of them spend the day) were more abundant there. A few were found on the open road banks. Occasionally one was found on the trunk, or in the low branches, of a spruce seedling, the highest being about 6 feet above the ground. Two were collected from the face of a low sandstone cliff, within a few inches of remnant ice formations of considerable size.

The point of collections is almost exactly 25 air-line miles northeast of Cheat Bridge, the type locality for this species, and is, so far as I am aware, the most northerly area in which it has been taken.

Plethodon wehrlei Fowler and Dunn.—Twenty-two specimens of this salamander were taken. Most were found along the road banks, although a few were in heavier stands of trees. Rock ledges outcropped along one side of the highway, and these situations appeared most favored by this species.

Dunn and others have called attention to the occasional red spots sometimes present on juveniles of this salamander. Three adults collected on this occasion are unique (in my experience at least) in having scattered or paired red spots along the dorsal surface from the neck to the base of the tail. One individual has six pairs of these red spots, regularly placed on the back, and a few scattered ones on the legs and along the sides of the tail. Most of the juveniles collected showed one or more red spots.

Eurycea longicauda longicauda (Green).—A juvenile was found where a small stream cuts across the road right-of-way. This is, so far as I know, the first of the species to be collected from the extensive Cheat Mountains system. Long-tailed salamanders, in this section at least, are much more likely to occur in limestone regions, and, although there are outcroppings of limestone at lower elevations on Shavers Mountain, my collecting was done in a region of sandstone. The specimen appears to represent, also, a new high altitude record for the species in West Virginia, 3500 feet being the highest previously recorded in Mr. Netting's tabulations.

Rana clamitans Latreille.—A single juvenile was taken from a flooded roadside ditch.

The absence of the generally common *Plethodon cinereus* is notable, and bears out the observation that where P. *nettingi* is abundant *P. cinereus* is often notably less so.

I am indebted to M. Graham Netting, who has examined this collection critically, and who has read these notes.—MAURICE BROOKS, *Division of Forestry, West Virginia University, Morgantown, West Virginia.*

AFRICAN NATIVE ATTACKED BY A FROG.—During a recent visit to the United States, Mr. T. L. Putnam told me of an incident so unusual that I decided to write his informant, Mons. C. Caseleyr, Administrator of the Niangara Territory, for further details of the affair. The following account embodies the information courteously supplied.

When Mons. Caseleyr was stationed at Tapili, Niangara, northeast Belgian Congo, one evening a native policeman came to him for iodine. In his hand he carried a large frog that he had killed with his stick. The man stated that he had been walking past a small pool when something bit his leg. Though it was dark he could see to club the creature that had attacked him, and was surprised to find it was a large frog. This policeman was well acquainted with the local herpetofauna but never before had heard of anyone being attacked by a frog. Mons. Caseleyr then examined the man's leg which bore "two punctures, very much like the marks a dog's teeth would leave. The man's leg swelled up rather badly and he was considerably bothered by it for a few days, after which the swelling went down."

On opening the frog's mouth Mons. Caselyr found two teeth like the canines of a dog, but much smaller, in the upper jaw, two similar teeth in the lower jaw. The tongue "was forked like that of a snake." The frog was the usual gray-green color above, with a large orange patch on the chest and belly. The amphibian was very large, broad, and fat, and "seemed to be rather of the toad family, although I know nothing of these matters."

The notched tongue would seem to rule out the possibility of the creature being a toad, and the pronounced teeth eliminate *Rana occipitalis,* the common bullfrog of the Niangara district. Niangara, however, is in the Sudanese zoological subprovince, and Franz Werner (1908 (1907), Sitzb, Akad. Wiss. Wien, 116, 1: 1888) has reported a 70 mm. ♀ bullfrog from Khor Attar on the White Nile. It is not unreasonable to suppose that the same species may occur in the northeast Belgian Congo, though as yet unknown from there.

Werner, while noting differences, referred his frog to the South African *Rana adspersa* (Tschudi), a species which has numerous fine teeth in the upper jaw and a pair of enormous tooth-like projections at the front of the lower jaw. In one 160 mm. (approx. 6½ inches) frog (MCZ 10826. ex. Dordrecht. Cape Province), these bony cusps rise 8 mm. ($\frac{5}{16}$ inch) from the jaw and are set 10 mm. (⅜ inch) apart with a minor cusp between them. Elsewhere (1936, Bull, Mus. Comp. Zool., 79: 408) I have shown that the name *edulis* (Peters) should be used for the frogs reported as *"adspersa"* ranging from Mozambique to Somaliland. Whether, as seems probable, *edulis* can be employed in a subspecific sense is not as yet clear, but it is reasonable to suppose that the Sudanese frog is referable to *edulis* rather than to southern *adspersa* or *bufonia* of Senegambia. It seems probable that *edulis* attains the size of *adspersa* though the largest ♀ *edulis* that I have taken measured only 145 mm. (approx. 5¾ inches) with cusps rising 4.5 mm. and set 10 mm. apart, but capable of inflicting a severe bite.

Whether the Belgian Congo frog was *edulis* must remain in doubt for neither *edulis* nor any other large frog known from this vicinity, has canine-like teeth in the upper jaw. As, however, Mons. Caseleyr writes of only two punctures on the askari's leg, it may be that his impression of cusps being present on both jaws is faulty. In view of the remarkably accurate account which he furnished, presumably written many months after he examined the frog, I suggest this possibility with considerable hesitation for it may be that some large species remains to be discovered in the Niangara region.

Rana edulis (or *Pyxicephalus edulis,* as some prefer to call it) is so hardily omnivorous as to be worthy of study. A few years ago (Bull. Mus. Comp. Zool., 91: 419) I invited attention to their apparent imperviousness to stings as deduced from stomach contents. In one frog that I caught at Mikindani, Tanganyika Territory, there were 3 scorpions each measuring 1¼ inches from head to end of sting; a centipede 4 inches long and ⅓ inch broad; a millipede 2¾ inches long; a scutigera; a carabid beetle 1½ inches long of a species that ejects formic acid; 3 black stink ants $\frac{11}{16}$ inch long, and the remains of a snail with shell $\frac{7}{16}$ in diameter. From time to time I have recorded similar strange assortments recovered from *edulis* stomachs.—ARTHUR LOVERIDGE, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

MORE REPTILES IN CORK SHIPMENTS.—Bales of cork-bark, exported to the United States from Spain, Portugal, or North Africa, occasionally contain reptile stowaways that hide in the cargo as it awaits shipment. Dillon (COPEIA, 1944: 188) has reported upon three European snakes that came to the United States in this fortuitous manner. I can add six lizards of four species that are indigenous to the western Mediterranean region—one specimen each of *Lacerta viridis, Lacerta muralis,* and *Lacerta lepida* and three of *Tarentola mauritanica.* Most of these were presented to the Philadelphia Zoological Garden by Mr. W. W. Keyser or by other persons associated with the Armstrong Cork Company. They found the lizards running at large on the piers or grounds of the company's receiving station at Gloucester, New Jersey. The specimens have been received over a period of many years, but the latest (*L. lepida*) was found in the summer of 1944. A single *Tarentola* was taken to the University of Delaware, Newark, Delaware, during the summer of 1943 after its capture in a cork storage yard at the edge of that town. This, like the Reading, Pennsylvania, station mentioned by Dillon, was a stock pile established by the Armstrong Company for government use. All six lizards appeared to be well nourished and in good condition when they were caught; they ranged in size from small to average for adults of their respective species.

Probably reptiles immigrate in cork more frequently than is realized, but their secretiveness and reluctance to leave their hiding places when human beings are near make them inconspicuous. During the more than two years that I served on the Philadelphia waterfront with the Volunteer Port Security Force of the United States Coast Guard I had occasion to spend much time aboard many Spanish and Portuguese vessels that were loaded largely with cork-bark. I did not see any reptiles on either the ships or piers, but I learned from stevedores and other employees that both lizards and snakes turned up occasionally. All were usually killed at once and thrown overboard or disposed of in other ways.

There is no evidence to indicate that any of these old world reptiles have succeeded in establishing themselves in the Philadelphia region as did *Lacerta melisellensis* (Kauffeld, COPEIA, 1931: 163).—ROGER CONANT, *Zoological Society of Philadelphia, Philadelphia, Pennsylvania.*

NOTES ON MARYLAND SALAMANDERS.—During the past summer, while conducting a survey of the salamanders of Maryland with Robert A. Littleford, the writer discovered an area noteworthy for the large number of species present. The site in question is in Allegany County, about 2½ miles north of Cumberland, on the Bedford Road, and is the location of a now abandoned sawmill. It covers an area 20 by 30 yards in extent. It was extremely damp and marshy, being watered by numerous underground streams.

The major collections were made during two trips on May 11, 1945, with a temperature of 58°F and an easterly wind. On the first trip we noted: 3 *Desmognathus f. fuscus*, 6 *Plethodon c. cinereus* (leaden), 1 *Eurycea l. longicauda,* and 1 *Hemidactylum scutatum.* The second trip made in the late afternoon was even more productive, and the following specimens were found: 6 *Eurycea b. bislineata,* 5 *Plethodon g. glutinosus,* 3 *Desmognathus f. fuscus*, 3 *Plethodon c. cinereus* (leaden), and 1 *Pseudotriton r. ruber.*

In addition to several of the species collected on these two trips, a visit on March 30, 1945, obtained 1 *Gyrinophilus p. porphyriticus.* Thus a total of eight species was collected in this relatively small area. At no time were any red-backed *Plethodon c. cinereus* found. WILLIAM F. KELLER, *Department of Zoology, University of Maryland, College Park, Maryland.*

ADDITIONAL NOTES ON THE NAME *TESTUDO TERRAPIN* SCHOEPF.—In my recent article on the status of the name *Testudo terrapin* Schoepf (COPEIA, 1944: 245–250), I completely overlooked certain references, and committed errors in spelling. These omissions and errors in no way alter the conclusions reached, but I wish to correct them.

Mr. M. Graham Netting points out to me that Gray's spelling of his genus of diamondback terrapins is *Malaclemys,* not *Malaclemmys.* The former orthography should

be substituted wherever *Malaclemmys* appears in my text except for citations of W. P. Hay, who uses the spelling *Malaclemmys.*

W. A. Lindholm (1929, Zool. Anz., 81: 294) seems to have been the first author to employ the combination *Malaclemys terrapin terrapin* for a diamondback. Conant and Bailey (1936, Occ. Pap. Mus. Zool. Univ. Mich., 328: 9), believing that Lindholm's *M. t. terrapin* was used to designate the northern race usually called *concentrica,* have so employed the name for New Jersey specimens. Actually, Conant and Bailey are entitled to recognition as the first authors to apply the name properly, for Lindholm's use of it is not clear. While Lindholm is entirely correct in pointing out that *Testudo terrapen* Lacépède and *Testudo terrapin* Schoepf are not homonymous, and that *terrapin* Schoepf is available for a race of *Malaclemys,* his further nomenclatural conclusions are confused beyond rectification. Lindholm states specifically (*loc. cit.*) that *centrata* Latreille and *terrapin* Schoepf are synonymous, but he then goes on to recognize both *M. t. terrapin* (Schoepf) and *M. t. concentrica* (Shaw). Inasmuch as the type locality for both names is the same and in view of the fact that Shaw's description and illustration of his *Testudo concentrica* were lifted in their entirety from Schoepf, one must be recognized to the exclusion of the other. It is possible that through a lapsus Lindholm confused *centrata* and *concentrica,* and actually meant to suppress the latter (in favor of *terrapin* Schoepf) and retain the former as a valid subspecies. In any case, Lindholm's *Malaclemys terrapin terrapin* (Schoepf) is, apparently, both fortuitous and confused.

Shortly after the appearance of the paper by Conant and Bailey, Stejneger published a short note (COPEIA, 1936: 115) in which he defended the use of *Malaclemys centrata concentrica* (Shaw) over *M. terrapin terrapin* (Schoepf) as the proper name for the northern diamondback. Stejneger's action was based chiefly on the fact that Schoepf supposedly drew his description of *Testudo terrapin* from Browne's *Civil and Natural History of Jamaica,* which was the source of Lacépède's *Testudo terrapen,* and on the supposition that Schoepf considered his species identical with that of Lacépède. I have shown (*loc. cit.*) that these considerations are in error. Schoepf clearly states that the description of his species is based on specimens obtained in the Philadelphia markets and the coastal waters of Long Island; further, Schoepf was fully aware of the distinctions between *terrapen* Lacépède of Jamaica, and his own, North American species, and even pointed out certain differences in structure as well as habitat. Schoepf's mention of Lacépède's *terrapen* and Gmelin's *palustris* was not intended as an appreciation of the possible identity of these species with his own, but rather to point out the similarity between *terrapen* and *palustris,* and to indicate that they were also terrapins in the vulgar sense, and hence of interest in connection with his discussion of his new North American species. In any case, Schoepf's very detailed description, excellently prepared plate, and clearly designated type locality, are quite sufficient to define the form in question adequately. Thus the northern diamondback is *Malaclemys terrapin terrapin* (Schoepf), 1793, and the more southerly race *Malaclemys terrapin centrata* (Latreille), 1802.—M. B. MITTLEMAN, *470 Pelham Road, New Rochelle, New York.*

PITUOPHIS MELANOLEUCUS MUGITUS IN ALABAMA.—Recently received at the Museum of Comparative Zoology is a specimen of *Pituophis melanoleucus mugitus* Barbour, from Silver Hill, Baldwin County, Alabama, collected by George Nelson in September, 1945. Baldwin County lies to the east of Mobile Bay. The subspecies is unrecorded from Alabama by Stull in her revision of the genus (1940, U.S. Nat. Mus. Bull. 175: 73). Haltom (1931, Ala. Mus. Nat. Hist. Pap., 11: 47) under *Pituophis melanoleucus,* records both *mugitus* and *lodingi* in the state, and mentions Mobile, Tuscaloosa, and Baldwin counties as localities, but fails to say whence each race comes. His plate 14 appears to be *mugitus,* but even so, the origin of his material is not mentioned.

As *Pituophis melanoleucus lodingi* is known from the area west of Mobile Bay, it appears likely that the ranges of *lodingi* and *mugitus* come in contact along the Mobile River.—BENJAMIN SHREVE, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

Ichthyological Notes

THE USE OF THE NAMES *HYPORHAMPHUS ROBERTI* AND *HYPORHAMPHUS HILDEBRANDI* FOR THE SAME HALFBEAK FISH OF TROPICAL AMERICA.[1]—During a recent survey of the American halfbeaks of the genera *Hyporhamphus* and *Hemiramphus* (Miller, 1945, Proc. U. S. Nat. Mus., 96: 185–193, fig. 9, pl. 11), I regarded *Hyporhamphus hildebrandi* as a synonym of *Hyporhamphus roberti,* the long-jawed halfbeak of tropical America. This opinion has just been confirmed by an examination of the types of *roberti* in the Muséum National d'Histoire Naturelle by Professor L. Bertin, who kindly supplied the following data for the two types, Nos. 3204 and 5634.

	No. 3204	No. 5634
Standard length, in mm.	116	115
Head, length in mm.	24	24
Lower jaw, length* in mm.	38	31

Gill-rakers on lower limb of first gill arch, 24
Pelvic fins inserted much nearer base of caudal than gill opening
Pectoral rays 10, 11.

* Measured from the tip of the upper jaw to the bony tip of the lower jaw.

The original description of *roberti* by Valenciennes (in Cuvier and Valenciennes, 1846, Hist. Nat. Pois., 19: 24–25) readily distinguished the species from *Hemiramphus brasiliensis* but was not detailed enough to separate it from *unifasciatus,* the common *Hyporhamphus* of American waters. Later, Jordan (1895, Proc. Calif. Acad. Sci., (2), 5: 415–416) made the following statement regarding a drawing of the type of *roberti* received from the Paris Museum: "In the drawing the lower jaw, from tip of upper, is 1¾ times length of head . . . The ventral is midway between front of eye and base of caudal." In my study of *H. unifasciatus* from both coasts of America, I found that the mandible of half-grown to adult fish varied from slightly longer than to equal to or slightly less than the head length. The anterior position of the pelvic fins, as erroneously portrayed on the drawing, may have led to the later change in names, described below.

Hyporhamphus hildebrandi was named by Jordan and Evermann (1927, Proc. Calif. Acad. Sci., (4), 16: 503–504) to replace *roberti* on the basis of the following statement: "This species is based upon specimens obtained by Meek and Hildebrand at Toro Point, Fox Bay, Colon, and identified by them with *Hemirhamphus roberti* Cuv. & Val., 1846, the type of which came from Cayenne and which is certainly identical with *Hemirhamphus unifasciatus* Ranzani, 1842, the type of which came from Brazil. These two nominal species appear to be identical, but the Fox Bay specimens seem to differ in some respects, chiefly in the greater number of gillrakers of which there are 28 to 31, while in *H. unifasciatus* there are only 20 to 24." There is no question that the long-jawed halfbeak is distinct from the short-jawed *unifasciatus,* but the substitution of *hildebrandi* for *roberti* is now seen to have been unjustified.

The greater length of the lower jaw (1.3 to 1.6 times head length, in contrast to 1.2 or usually much less in half-grown and adult *unifasciatus*), and the posterior position of the pelvic fins (about equidistant between caudal base and some point anterior to margin of preopercle in *unifasciatus*), as well as the absence of definite scales on dorsal and anal fins (which are densely scaled, at least basally, in *unifasciatus*), serve to distinguish *roberti* from *unifasciatus.* The number of gill-rakers, usually 20 to 25 in *unifasciatus* and 28 to 31 in Panama material of *roberti* (Meek and Hildebrand, 1923, Publ. Field Mus. Nat. Hist., Zool. Ser., 15: 236–237, 239) can no longer be used to separate all populations of these two species, for I find that *unifasciatus* has as many as 27 gill-rakers and *roberti* has as few as 24. In addition to the types of *roberti,* I counted as few as 24 rakers in specimens of this species from Lake Maracaibo, Venezuela (USNM Nos. 121725, and 121816–121820).

The known range of *Hyporhamphus roberti* is from the Atlantic Coast of Panama southward to Pernambuco, Brazil (Gilbert, Proc. Wash. Acad. Sci., 2, 1900: 164).—ROBERT R. MILLER, *U. S. National Museum, Washington 25, D. C.*

1 Published by permission of the Secretary of the Smithsonian Institution.

SUPPLEMENTAL NOTES ON MOSQUITO FISH IN UTAH, *GAMBUSIA AFFINIS* (BAIRD AND GIRARD).—In COPEIA (1934. (4): 157–159), the author presented an article entitled, "Notes on Mosquito Fish in Utah, *Gambusia affinis* (Baird and Girard)," discussing the introduction of *Gambusia* into Utah in 1931 from Tennessee and their maintenance and use to 1934.

Since then, *Gambusia* have become abundant and we believe permanently established in Salt Lake City and vicinity and also in other parts of the state where they have been planted in water suitable for survival. The principal difficulty encountered in establishing this species in Utah was to find water in which it could survive the severe winters of this region. *Gambusia* in this area thrive and multiply rapidly during the summer in practically every locality where they are planted; but all of them perish during the winter in many localities where they are numerous during the summer months. The severity of the winter determines in part the number of places in which the fish survive. Thus, during mild open winters these fish survive in a far greater number of localities than they do during more severe winters.

The first winter, 1932–1933, during which *Gambusia* were allowed to remain in outside pools, they survived only in water from thermal springs. During the following mild winter of 1933–1934 they survived not only in these warm waters but also in several cold water pools and streams. Each winter since 1934 to the present these fish have been able to survive the winter in Utah, under certain favorable conditions, in cold water habitats; but the number of such habitats has remained relatively constant for several winters, and has thus apparently reached its maximum in Salt Lake City and vicinity, fluctuating between approximately one and two hundred localities, depending on the severity of the winter.

In a survey completed by the author July 30, 1945, it was evident that *Gambusia* have become established in Utah in several counties other than Salt Lake. At Saratoga Springs in Utah County these fish are extremely abundant and a few were found in this county at Payson, 65 miles south of Salt Lake City. It is significant that the last planting in Utah County was made in 1937. *Gambusia* were also found in several localities north of Salt Lake City in Davis, Weber, Morgan and Box-Elder counties, a maximum distance also of about 65 miles. Some isolated places where *Gambusia* were extremely abundant, such as Como Springs, Morgan County, have not been planted with these fish since 1935, showing an independent survival of at least 9 years in this locality.

During the past 8 years a study of over-wintering requirements and habits of *Gambusia* has been made in Salt Lake City and vicinity. The recent survey in other counties to determine where and under what conditions this species had survived in these areas was a correlating check on the data collected in Salt Lake City.

It is apparent from this study that *Gambusia* in Utah are more readily established in water from thermal springs as evidenced by plantings in the warm springs north of Salt Lake City and Ogden and at Saratoga Springs in Utah County, where water temperatures range from 41° to 23° C. and lower as it is cooled by the atmosphere. In water of this nature food seems to be sufficient and other conditions satisfactory to keep the fish active and propagating through the year, although growth and reproduction are not as rapid during the winter months as during other seasons.

Gambusia are also able to survive the winter in this area, providing other conditions are favorable, in water ranging from 22° to 0° C. *Gambusia* surviving in cold water habitats do not reproduce during the winter when water temperatures are near freezing and growth and other activities are greatly retarded. However, from observations in the field and under laboratory conditions in Utah there is no evidence to date that *Gambusia* pass the winter hibernating in the mud at the bottom of ponds and streams.

The immediate source of the water, with subsequent environmental effects, is the most important factor in determining the winter survival of *Gambusia* in Utah, since it has been determined that, except for a few explainable exceptions, they survive the winter only in water near its emergence from springs or artesian wells. In water from this source temperatures remain relatively constant, the water is well aerated and remains open and comparatively free from ice. These conditions are favorable to the top feeding and breathing habits of these fish, they are conducive to the production of food, and thus provide the essential requirements for their winter survival.—DON M. REES, *Biology Department, University of Utah, Salt Lake City, Utah.*

THE FLACCID FISH, *ZAPRORA SILENUS*, FROM OFF NEWPORT, OREGON.[1] —Recently the United States National Museum received a frozen specimen of the "highbrow," *Zaprora silenus* Jordan, from the Oregon State College, Food Industries Department, Seafoods Laboratory, through the kindness of Dr. E. W. Harvey. This fine specimen, now preserved, bears USNM No. 131608. It was captured by Captain W. L. Miller of Astoria, Oregon, West by North off Newport, Oregon, in 105 fathoms of water during the spring of 1945. It measured 660 mm. in standard length.

The senior author reported upon Alaskan specimens of this species in COPEIA (1934 (2): 98). Other localities were summarized by Schultz and DeLacy in the Mid-Pacific Magazine, (1938, April-June:138). Chapman and Townsend published a paper on *Zaprora silenus* in the Annals and Magazine of Natural History (1938, Ser. 11, 2), and summarized the distribution of the species on pages 89 and 90. All of their 36 specimens were postlarvae measuring from 11.2 to 72.0 mm. in standard length, taken south of the Alaskan Peninsula from Afognak Island to the Shumagin Islands, between 151° W. and 161° W. longitude, except one from Dixon Entrance.

Other localities where *Zaprora silenus* have been reported in the literature are: Strait of Juan de Fuca, near Victoria, B. C.; at latitude 58° 05′ N., longitude 149° W.; off Anthony Island; off the southwest coast of Vancouver Island; off Sitkalidak, Akutan, and Kodiak Islands.

The present specimen of *Zaprora silenus* extends the range of this species about 230 miles southward from the Strait of Juan du Fuca to off Newport, Oregon. This town lies at the mouth of the Yaquina River. In addition to the 36 postlarval specimens, this one represents the fourteenth larger one recorded to our knowledge.—LEONARD P. SCHULTZ and EDWARD W. HARVEY, *United States National Museum, Washington 25, D. C.* and *Oregon State College, Sea Foods Laboratory, Astoria, Oregon.*

1 Published with the permission of the Secretary of the Smithsonian Institution.

REVIEWS AND COMMENTS

A NATURALIST IN CUBA. By Thomas Barbour. Little Brown and Co., Boston, X + 317 pp. illus. $3.00.—Dr. Barbour's host of friends will again be delighted at the appearance of a third book of reminiscences from his pen. He dedicates it specifically as a tribute to commemorate his friendship and admiration for the naturalists of Cuba. It forms also a most satisfactory memorial record of a lifelong love of an island. The generous stack of papers on the West Indian fauna that came to my own desk as a gift from Dr. Barbour thirty years ago introduced me at once to the charm of the West Indies, and to the stimulus provided by one's personal library to a field of specialization.

The personal tone of Dr. Barbour's book, and the constant reference to the background of personalities that forms so pervasive an aura of interest to the other practitioners of descriptive zoology, is peculiarly sympathetic. He has a vast fund of anecdote about the development of the important Harvard Botanical Station, about the bird collecting that accumulated the great collecion in the Museum of Comparative Zoology, about the fascinating anoles and snakes and froglets and shield-headed toads, about the mammals, both living and extinct, and about the adventures of cave hunting.

A Naturalist in Cuba thus happily combines the interests of naturalist and historian, and forms a thoroughly satisfactory introduction to the plant and animal life of Cuba, to the problems of island life, and to the great tropical island to which citizens of the United States are perhaps even more closely and multifariously tied than to our own island outposts in the Caribbean.—KARL SCHMIDT, *Chicago Natural History Museum, Chicago, Illinois.*

THE LIFE HISTORY OF AN AMERICAN NATURALIST. By Francis B. Sumner. The Jacques Cattell Press, Lancaster, Pa. VII + 298. $3.00.—Brilliance and originality of mind, tenacity of purpose, and a sound background of university training and travel combined to render the research career of Francis B. Sumner a peculiarly effective one. Standing aloof from the popular schools, his investigations had a quality of independence that gave them especial force as they impinged on such major biological controversies as those over the effectiveness of protective resemblance in natural selection, the mechanisms and limitations of color change, and especially of the relations of the new science of genetics to older ideas and to the taxonomic categories of systematic zoologists. His autobiography is a valuable record of this career, and of his personal background.

It is accordingly extremely disappointing to report that his own account of his life is written in a pedestrian style, with far too little of the framework of the general problems upon which his research was brought to bear, and without adequate editorial aid. The use of quotation marks and exclamation points is carried to a painful extreme. Qualifications like 'not altogether,' 'rather,' etc., appropriate as scientific caution (otherwise "hedging") in a technical report, destroy the force of sentence after sentence; and paragraph after paragraph ends in an anticlimax. Cliche's' like "dear reader," "come to pass," "the good life," together with garbled quotations are part of the literary medium. No inkling appears of the clarifying distinction between the relative pronouns which and that. All this is unfortunately emphasized by Dr. Sumner's belief that his literary style is unusually good. He naively writes that a single paragraph may have occupied him for as much as an hour. All these minor defects might be quite unnoticeable had the publishers seized the obvious opportunity to enliven the book with illustration. The need for adequate presentation of the methods and results of scientific experimentation to the general public is great, and the illustrations in Sumner's published researches on animal coloration and variation would have gone far toward bridging the gap between scientist and layman. The flounder on a checkerboard (which shows how a flounder cannot imitate the checkerboard pattern) would have given invaluable emphasis to his remarks on the failure of his colleagues to read attentively the works they cite. There is no portrait of Sumner, no views of the Woods Hole or La Jolla stations, no illustration of *Polypterus* (which might have helped his colleagues to note that it was not the African lungfish that was so expensive a fish for Columbia University), and none of the white-footed mice or of the methods of trapping them. Rarely has there been a better opportunity for effective illustration of a book. The typography seems needlessly crude. The book mentions so many persons of note, so many places of interest, and so many subjects of research to which one might certainly wish to refer that the lack of an index is inexcusable.—Karl P. Schmidt, *Chicago Natural History Museum, Chicago, Illinois.*

Editorial Notes and News

April Meeting It was the desire of the officers to hold the first postwar meeting of the Society in Rochester, since a projected meeting in this city several years ago had to be deferred because of wartime restrictions. Unfortunately, hotel facilities will not be available in Rochester in the near future. It has been decided, therefore, to hold the 1946 Annual Meeting in Pittsburgh, on Tuesday, Wednesday, and Thursday, April 16 to 18. The American Society of Mammalogists will also meet at the Carnegie Museum, from April 18 to 20. It is expected that at least one joint session of the two organizations will be held on the overlapping day, and a combined evening smoker will be arranged. Full details with respect to hotel accommodations, etc., will be sent to members early in 1946.

New Awards THREE members of the Society have generously offered to provide, for a minimum of three years, awards for noteworthy papers read by junior members at both the Annual and Western Division meetings of the Society. Four awards will be offered at each meeting; namely, a first prize of $25.00 and a second prize of $15.00 in the field of ichthyology (including fisheries), and two prizes of the same amounts in herpetology. The selections will be decided upon by a committee appointed by the presiding officer at each meeting. Awards will be granted only for papers that are judged to be of high quality. Consequently, the number of awards at any one meeting may vary from zero to four.

Junior members are defined as those who have not been awarded the doctorate, or who are not professionally employed as ichthyologists, fisheries biologists, or herpetologists. Obviously, students will comprise the majority of those meeting these qualifications, but amateurs of any age are equally eligible.

Honor Roll WE announce with deepest regret the death of PFC. CLIFFORD A. GOODNOH, JR., who was killed in Belgium in the "Battle of the Bulge" on January 11, 1945. Mr. Goodnoh, who entered the Army in 1944, at the age of eighteen, was an enthusiastic member of the Junior Explorers Club, of the New England Museum of Natural History, and of the A. S. I. H. He is buried in the Henri Chapelle Military Cemetery near Aachen and was posthumously awarded the Purple Heart.

News Notes UNDER a program jointly administered by the Foreign Economic Administration, the International Training Administration, and the Fish and Wildlife Service, five Chinese citizens, technical employees of the Chinese Government, are now studying fishery science in the United States. The program of training Chinese fishery workers in the United States is designed to provide trained men who can aid China in rehabilitating and developing her marine fisheries devastated by the war. Reporting to the Fish and Wildlife Service, in Washington, D.C. on June 28, 1945, the trainees were given a 60-day orientation course, consisting of lectures by members of the staff, demonstrations, and field trips to nearby commercial fishery plants and laboratories. Following the orientation, the men were assigned to field activities. CHEN HSIU PAI, following an assignment to the U.S. Fishery Laboratory, College Park, Maryland, enrolled in the School of Fisheries, University of Washington, and in addition is working in the U.S. Fishery Laboratory at Seattle, Washington. Also studying at the University of Washington and the Seattle laboratory is TI CHOW, who previously studied in the United States. SZE SUNG SHENG is working in the fishery market news office in Seattle, in addition to taking special courses at the University of Washington. SHEEN HANN SHYANG is assigned to the technological laboratory of the Fish and Wildlife Service at Boston, Massachusetts, and TSOU WU is enrolled at Stanford University, Stanford University, California.

DR. BAINI PRASHAD, Director, Zoological Survey of India and now serving his government as fishery development advisor, arrived in the United States in July. He is visiting leading fishery production plants, and offices and laboratories of state, provincial, and federal organizations in the United States and Canada related to the fisheries, in preparation for the establishment of an official fishery development program in India. While here, Dr. Prashad has also served as technical specialist in fisheries to the delegate of the Indian Agent General at the United Nations Food and Agricultural Organization Conference at Ottawa, Canada. Following his return from the conference, he will complete his inspection in the southern United States and plans to leave for India early in January.

Word has been received by LEO SHAPOVOLOV from PROF. I. F. PRAVDIN, Leningrad State University, Leningrad, U.S.S.R., of the deaths of the well-known ichthyologists V. K. SOLDATOV, A. I. BEREZOVSKY, and A. J. TARANETZ. Insofar as Prof. Pravdin knows, DR. SERGIUS AWERINZEW was also lost during the war.

José Alvarez del Villar of Mexico City, Mexico, returned to his home on October 1, 1945, following the successful completion of his in-service training fellowship in fish culture and fishery biology, awarded by the Director of the Fish and Wildlife Service under the program of the United States Government for cooperation with the American Republics. Mr. Alvarez arrived in the United States June 21, 1944, and during his stay studied at several of the laboratories and offices of the Fish and Wildlife Service and was enrolled in the Alabama Polytechnic Institute and the University of Michigan, receiving the degree of Master of Science from the latter. He is now Professor of Zoology at the Instituto Politécnico Nacionál.

Announcement has been made that the eleventh North American Wildlife Conference will be held in New York City, March 11, 12, and 13, 1946. The 1945 Conference was postponed due to travel restrictions and plans are being made for an even larger conference than planned for that year. Hundreds of wildlife technicians and scientists released from the Armed Forces want to familiarize themselves with current programs and some people may not be able to secure suitable accommodations if reservations are not made weeks in advance. The 3-day session will be consumed by reports on recent developments in field techniques and discussions of future plans for natural resource conservation and restoration work throughout North America. Representatives from Canada and Mexico will attend the meetings to be held in the Hotel Pennyslvania. All of the state and federal conservation officials depend upon this conference sponsored by the American Wildlife Institute to observe the trend of affairs throughout the nation. There is especial need for the coming meeting to coordinate the efforts of all groups and agencies in an effort to replenish the natural resources diminished by years of war.

Dr. Canuto Manuel writes from the Phillippines that his manuscript check-list of Philippine birds, which was ready for the press, other bird studies, and all his library and other scientific material, were lost in the destruction of the Bureau of Science building. The Museum of the Bureau of Science was also destroyed, and help in its restoration is urgently needed. The Library of the Bureau also needs replacement. Specimens and literature should not be sent immediately, however, for almost all of the government section of Manila is still in ruins. Dr. Deogracias Villadolid, who directed the Bureau of Fisheries during the war, has returned to the fisheries service.

A letter received recently by Dr. Leonard Schultz from Dr. Th. Monod, Director of the Institut Francais d'Afrique Noire, Dakar, French West Africa, contains interesting news of French ichthyologists. This is a new research institution covering anthropology and natural history. Dr. Monod hopes to have a special Section on hydrobiology, fisheries investigations and marine biology, with a number of field laboratories for studying special problems. He himself has begun investigations on the biology of the fishes of the Niger. The library of the Institut is still small and Dr. Monod will be grateful for contributions of literature from American scientists.

Dr. Monod also succeeded the late Prof. A. Gruvel, as head of the Colonial Fisheries Department in the Muséum Nacional d'Histoire Naturelle, so he will spend a few months each year in Paris, where his assistant is Dr. Budker, a specialist on Elasmobranchii. Prof. L. Bertin became curator of fishes and reptiles in the Muséum on the death of Prof. Pellegrin, and Prof. Fage is at the Muséum and also the Institut Océanographique (biological department). Dr. Monod mentions also the fisheries experts and ichthyologists MM. Legall, Belloc, Desbrosses, Furnestin and Cadenat at the Office Scientifique et Technique des Pêches Maritimes.

From France, Francis H. Sumner, fisheries biologist of the Oregon Game Commission, who has now been released from our armed forces, wrote of his visits with ichthyologists Léon Bertin and Paul Chabanaud. Dr. Bertin has been making extensive biometrical studies of *Gasterosteus*. He is also interested in trout. Dr. Chabanaud is continuing his studies on the flatfishes, in particular the soles. Their address is: Museum d'Histoire Naturelle, 57, rue Cuvier, Paris 5, France.

Mr. Sumner also described his visit with M. Paul Vivier, Directeur de la Station Centrale d'Hydrobiologie Appliquée and Inspecteur Principal des Eaux et Forêts, 12, rue de Buffon, Paris 5, France. M. Vivier's department is proceeding with the establishment of a fresh-water fisheries biological station.

"Play" of Fishes

THE March issue (1945) of COPEIA carries a note by Professor D. H. Wenrich describing a particular kind of behavior characteristic of certain small fishes. Referring to a more extensive article on the same subject by Dr. E. W. Gudger (1944, Am. Nat., 78: 451–463), Wenrich adds his own observations on fishes which leap over small sticks floating in the water. The account closes with the following comment: "To me this behavior suggested play and I am still inclined to believe that this is the best interpretation for the performance here described."

This is to raise the question as to whether the labelling of an act as "playful" can properly be regarded as interpretation. It seems to me that no interpretation and no explanation are here involved. All that has been done is to equate, by inference, an overt response of the fish with a poorly understood and only partially explored category of human activity. There are several valid objections to such procedure. Psychologists have not as yet achieved any high degree of agreement in their interpretations of human play. Therefore to "interpret" the behavior of fishes as play is to do more than express one unknown in terms of a second.

Modern studies of comparative psychology have repeatedly established the impossibility of determining, without extensive experimental investigation, the motives and ends of animal conduct. The type of behavior under consideration is a case in point. Breder (1932, Carnegie Inst. Wash. Publ. 435, 28: 8–9) has pointed out the possibility that the leaping of fish over floating objects may serve to dislodge ectoparasites. Whether or not this explanation is valid is beside the point. The important aspect of the situation is that possible utilitarian function would preclude the classification of the behavior as play according to certain definitions. Of course opponents of this point of view might object, stating that activity may be utilitarian and still be properly classified as play. It is of course the privilege of any writer to define play as he sees fit, but the term is so ambiguous that in the absence of a specific definition it cannot be used in an interpretative sense.—F. A. BEACH, *American Museum of Natural History, New York.*

Editorial Notes

A RECENT letter from DR. DORIS COCHRAN, of the U. S. National Museum, presents a timely and urgent plea for the sending of food boxes to our European colleagues to aid them through the bitter winter months. Dr. Cochran has learned from DR. GASTON DE WITTE, of the Brussels Museum, that several members of his family were executed by the Germans for sabotage, or were sent to prison camps. However, he has managed to continue his work on herpetology. DR. ANGEL, of the Paris Museum, writes that he lost 32 kilos (64 pounds!) during the German occupation, but is keeping up his work. Contributions toward sending food to our honorary foreign members and to other allied colleagues will indicate to them our deep interest in their welfare. DR. COCHRAN will be happy to furnish information regarding needs and addresses. Two firms specializing in such boxes are Fraser, Morris & Co., 630 Fifth Ave., New York 20, N.Y., and Marshall Ellis Ltd., 138 McGill St., Montreal, Canada. Prices of boxes range from $5 to $10.

The able assistance of DRS. NORMAN HARTWEG and REEVE BAILEY, of the Museum of Zoology, University of Michigan, in getting out the last two issues of COPEIA, is gratefully acknowledged by the Editors.

Corrections

IN COPEIA, 1945, 2, p. 111, is an error in my article on the frogfish. The last sentence in paragraph 3 reads: "Recently this fishing has also been observed in the Chicago Aquarium."

This through an error of the observer was reported for *Lophius*, but it actually refers to *Antennarius striatus*. Will those who have COPEIA add the words—*Antennarius striatus*.—E. W. GUDGER, *American Museum of Natural History, New York, New York.*

A letter from MAJOR STANLEY S. FLOWER calls attention to a misprint in COPEIA, 1945 (2) as follows: on page 111, line 17 from top, Isle of Wight has been printed in error for Isle of Man.

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New names and their principal references are printed in bold face type.

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